

THE James Leffel

Standard SPECIAL

AND Samson

WATER WHEELS

BUILT BY,

JAMES LEFFEL & CO

HYDRAULIC
AND MECHANICAL

ENGINEERS
SPRINGFIELD, OHIO.

U.S.A.

NEW YORK

SAMSON COMPLIMENTS.

M. M. Simmons, Mogul, Miss., says: "I am using your 35 inch Samson Wheel, and also another kind of 42 inch. The Samson is much the best wheel, giving almost double the amount of power, and much the highest speed, with only one-third more water."

The Arkansas City Milling Co., say: "The 50-inch Samson James Leffel Wheel we put in last summer is doing our work in fine shape, and we consider it by far the best Wheel in the market today. One great advantage of your Wheel is, it will work a governor, and this is more than many will do."

Fred. W. Allen, Middle Granville, N. Y., says: "The Samson 30-inch Wheel purchased of you last spring, has run about 12 hours a day since, and it has proved more than satisfactory. I think some now of connecting my whole mill to it. You may refer any parties to me." (*Flour and Feed Mill.*)

B. F. Reeder, Georgetown, Ky., writes: "Allow me the privilege of expressing a few thoughts on your Samson Water Wheel. Under 7 feet head water, it runs five double set of rolls, making 65 barrels of flour every 24 hours and drives one corn roll, grinding 20 bushels of meal per hour, and runs other machinery, using one-half gate of water. I think it is the grandest water wheel I ever run. I have run some six other makes and I think you have a 50 per cent better wheel in every respect. I have been milling for 40 years, having charge of some of the largest Mills in the U. S."

John B. Wilhoite & Son, Wilhoite, Tenn., write: "The 50-inch Samson Wheel is now set and runs our 40 Barrel Full Roller Process Mill, to its proper speed and capacity with half gate under 4 feet head. We do not believe there is a wheel of its size made, using the same amount of water, that will equal it. The gates work easy, and stand at any opening without fastening. We think too much can not be said of this wheel. We have used several other wheels, but none to compare with this."

Geo. A. Pierce, Gen. Mgr. City Mills Co., Columbus, Ga., says. "After thinking and weighing the matter carefully, I finally bought your Wheels. I am more than satisfied with them. They are today doing work that would surprise you. (Three large Samson Wheels.—J. L. & Co.)

B. C. Oneal, Wild Goose, Tenn., says: "The Samson 26-inch Wheel purchased of you is as good a wheel as I want. I can saw three to four thousand feet of lumber per day; I can run two 50 saw gins and a 36-inch corn mill at same time, with one-half gate, under 9 feet working head. I can't see how much better one could wish."

A. M. Esler, Gem, Idaho. "We have been using for nearly a year one of your improved double discharge mining wheels, 10 inches diameter, under 90 ft. head. It furnishes power to run all of our concentrating mill machinery, with a daily capacity of 80 tons of hard ore, which we intend to soon increase to 120 tons daily, and we consider that the wheel will furnish us ample power to run the whole mill with increased capacity. We believe it the best water wheel made."

(James Leffel Water Wheels. Built by James Leffel & Co., Springfield, Ohio.)

F. L. Garrison

1894 New Pamphlet 1895

— OF THE —

JAMES LEFFEL

WATER WHEELS,
Standards, Specials *and* Samsons,

— BUILT BY —

THE OLD RELIABLE AND CELEBRATED HOUSE

— OF —

JAMES LEFFEL & CO.

32 YEARS IN BUSINESS.

SPRINGFIELD, OHIO, U. S. A.,

— AND —

NEW YORK CITY.

1894.

PREFACE

This Pamphlet contains most of the important matter, published by us in our Catalogues from time to time. It presents also considerable new matter suggested by our recent extensive trade, and our former long experience. It will be impossible to publish in a hand-book as much as we desire; but we aim to include that of most value and interest to our patrons and correspondents. Some years ago we printed a pamphlet of 160 pages, 68 of which were devoted exclusively to names and users of our Water Wheel, giving size of wheel, head-water, and kind of factory. It enumerated near 5000 mills driven by our Leffel Wheel. The present edition omits all matter of this character.

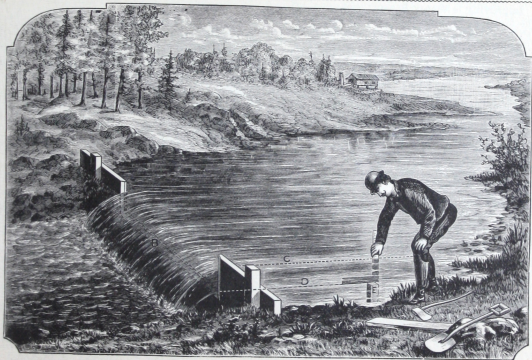
An entirely new feature in Water Wheel tables is introduced; which is exclusively our own. The usual fractional parts of horse-powers are omitted where practicable; especially in the larger powers of the larger wheels. When the fractional part is retained, the nearest proper fraction is substituted for the decimal, rendering it much more easily understood by a large class of our correspondents. The professional engineer in case of extensive computations, may prefer the decimal form. Our large experience with the general user of wheels, convinces us that this class of customers will appreciate the simple and practical character of our new method of recording the horse powers.

We have printed heretofore a large number of testimonials of the highest character, but our want of space will admit of a few extracts only of the several thousand letters now in our possession. Those given herein are brief, but show the good feeling of our patrons, towards the excellence of our work, and its satisfactory performance.

INTRODUCTORY REMARKS.

Several members of our firm have a practical hydraulic experience, extending through a period of more than forty years. They have witnessed the evolution of the Turbine, from the crude paddle Wheel to its present State of perfection. The simplest early forms, consisted of a class of paddle and flutter Wheels, which utilized only the impulsive action of the water. These were followed by the simpler styles, of reaction Wheels, mostly on horizontal shafts; among which in this country were the Parker, Rose, and others. This type was soon succeeded by the Fourneyron, Fontaine and other foreign Wheels. Improvements were soon applied in this country, and some old theories of their action exploded by such practical men as James Leffel, who combined the principles of pressure, and reaction.

Previous to James Leffel's radical, and unexcelled improvements, all the best Wheels comprised three classes; viz., the outward, the downward, and the inward discharge; these latter terms relate to the direction of water emerging from the buckets, when placed on upright shafts. James Leffel quickly appreciated the utility, and practicability of uniting and improving at the same time, two of the best forms. Perfecting his idea through extensive, and tedious experiments with various modifications, he obtained a Wheel, consisting of two Wheels united into one. It comprised a combination of a central, and a downward discharge Wheel; thus developing the world-renowned and justly celebrated James Leffel Double Turbine.



WEIR DAM MEASUREMENT. (See next page.)

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Improving a Water Power. (*Measuring Streams.*)

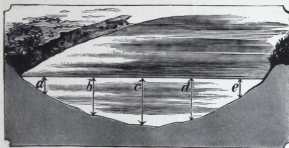
The first thing necessary is to know the amount of head and fall that can be secured. The next step is to ascertain the quantity of water the stream affords. The quantity of water can be closely estimated by the following plain suggestions and the illustration on preceding page. Use a board long enough to reach across the stream, with each end set in the bank. Cut a notch in the board, deep enough to pass all the water, and long enough to reach about two-thirds across the stream. The bottom and ends of the notch B in the board should be beveled on the down stream side, leaving the upper edge al-stream, most sharp. The stake E, should be driven in the bottom of the several feet above the board, on a level with the notch B; this level being easily found, when the water is beginning to spill over the board.

After the water has come to a stand, and reached its greatest depth, a careful measurement can be made of the depth of water over the top of stake E. Such measurement gives the true depth of water passing over the notch, because if measured directly on the notch, the curvature of water would reduce the depth. The line D is a level from the bottom of notch B, to the top of stake E; while the dotted line C represents the top of the water, and the distance between the lines gives the true depth, or spill over the weir board. The line D has the appearance of running over the top of the board; when in fact it passes behind it—the reader is supposed to look through the board and the post. The surface of water after passing below the board, should not be nearer the notch B than ten inches. Neither should the nature of the channel above the board, be such as to force or hurry the water to the board; but should be amply wide and deep, to allow the water to approach the notch quietly. If it passes the channel rapidly, it will be forced over the notch and a larger quantity will pass, than the table indicates.

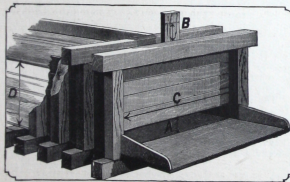
The weir table herewith gives the number of cubic feet of water passing per minute, over the notch for each inch in breadth. The figures 1, 2, 3, etc., in the first vertical column, are the inches depth of water over the weir; the first or top horizontal line is

Inch.		1/8	1/4	3/8	1/2	5/8	3/4	7/8
1	.40	.47	.55	.65	.74	.83	.93	1.0
2	1.14	1.24	1.36	1.47	1.59	1.71	1.83	1.9
3	2.09	2.23	2.36	2.50	2.63	2.78	2.92	3.0
4	3.22	3.37	3.52	3.68	3.83	3.99	4.16	4.3
5	4.50	4.67	4.84	5.01	5.18	5.36	5.54	5.7
6	5.90	6.09	6.28	6.47	6.65	6.85	7.05	7.2
7	7.44	7.64	7.84	8.05	8.25	8.45	8.66	8.8
8	9.10	9.31	9.52	9.74	9.96	10.18	10.40	10.6
9	10.86	11.08	11.31	11.54	11.77	12.00	12.23	12.4
10	12.71	13.95	13.19	13.43	13.67	13.93	14.16	14.4
11	14.67	14.92	15.18	15.43	15.67	15.96	16.20	16.4
12	16.73	16.99	17.26	17.52	17.78	18.05	18.32	18.5
13	18.87	19.14	19.42	19.69	19.97	20.24	20.52	20.8
14	21.09	21.37	21.65	21.94	22.22	22.51	22.79	23.0
15	23.38	23.67	23.97	24.26	24.56	24.86	25.16	25.4
16	25.76	26.06	26.36	26.66	26.97	27.27	27.58	27.8
17	28.20	28.51	28.82	29.14	29.45	29.76	30.08	30.3
18	30.70	31.02	31.34	31.66	31.98	32.31	32.63	32.9
19	33.29	33.61	33.94	34.27	34.60	34.94	35.27	35.6
20	35.94	36.27	36.60	36.94	37.28	37.62	37.96	38.3
21	38.65	39.00	39.34	39.69	40.04	40.39	40.73	41.0
22	41.43	41.78	42.13	42.49	42.84	43.20	43.56	43.9
23	44.28	44.64	45.00	45.38	45.71	46.08	46.43	46.8
24	47.18	47.55	47.91	48.28	48.65	49.02	49.39	49.7

Weir Table, 1 to 25 Inches.



MEASUREMENT OF LARGE STREAMS.



MEASURING WATER ON OVERSHOTS.

fractional parts of an inch. The body of the table shows the cubic feet, that will pass each minute, for each inch depth of weir, from 1 to 25 inches. Each of these results is for one inch in width; for any particular number of inches width of weir, the result obtained in table, must be multiplied by the number of inches of breadth the weir may be.

Suppose the notch in the board is twenty inches wide; and the water at the stake E, $5\frac{1}{2}$ inches deep; in the first column find the figure 5. Follow the horizontal line of figures until a vertical column is reached containing $\frac{1}{2}$ fraction at the top. The square where these two columns meet will contain 5.18 (five and eighteen-hundredths) cubic feet. This is the quantity of water passing for each inch in width; since the supposed weir is twenty inches, this result must be multiplied by 20, which gives 103.6 (one hundred and three and six-tenths) cubic feet per minute. In this manner the water passing any width of weir, of any depth from 1 to 25 inches, can be easily calculated.

An important matter in measuring small streams, is the possibility of damming or holding the water, and using it a part of the time instead of constantly. If the water is held for twelve hours, and the whole quantity used in the next twelve hours, with the supply that the stream affords in the same time, the power of the stream would be doubled, for the twelve hours, and give a better effect than if used constantly. This method may appear simple, but we request that parties give us the depth, and width of the water over the weir, so we can make the calculations ourselves. Always state whether storage room can be had to hold the water part of the time, especially if the stream is a small one.

Measurement of Large Streams.

Where it is impossible to construct a weir, one of the simplest methods is to ascertain the mean velocity of

the stream in feet per minute; next ascertain the area or cross section of the stream in square feet; their product will give the required quantity afforded by the stream. The velocity can be estimated by throwing floating bodies into the stream. The time they are passing a given distance can be ascertained, but it must be remembered that the velocity is the greatest in the centre of the stream and near the surface, and that it is least near the bottom and sides. It is best to ascertain the velocity at the centre, and from this the mean velocity can be estimated, as it has been reliably ascertained by experiments, that the mean velocity will be 83 per cent., or about four-fifths of the velocity of the surface.

The cross section may be estimated by measuring the depth of the stream, at a number of points at equal distances apart, as seen at points *a, b, c, d*, etc. Measure the depth at each of these points, add all of these together, then multiply their sum, by the distance in feet between any two of the points. In driving these stakes, the first one on each side should be half the distance from the edge of the water to the stake, that any one of the other spaces will measure; the two end or half spaces together, amounting to one whole space. Having obtained the cross section of the stream in square feet, and also the mean velocity of the water in feet per minute, the product of these two obtains the quantity of water, that the stream affords in cubic feet per minute.

Measurements of Water on Overshots. (See page 5.)

The illustration shows another method of measuring water in a stream. This plan can be adopted where the overshot wheel is in use, when the weir method can not be employed. It consists in measuring the opening of the gate, that lets the water upon the overshot wheel. The gate may be raised as shown at letter A, and the measure can easily be taken at the top of the capsil shown at the letter B; the top line at B is flush with the capsil when the gate is closed. When the gate is opened the line of course rises, and gives the measurement of the opening, if the bottom of the gate rests flush with floor of chute or spout. The length of the opening or gate is shown at letter C. These two measurements in inches, may be multiplied together, the product gives the aggregate number of square inches opening. Both of these measurements should be accurately made. The next matter is the depth of water in the forebay, over the floor or chute, as shown at letter D. This depth of water gives the velocity with which the water issues, through the gate opening upon the wheel, and this velocity must be multiplied into the number of square inches opening that we have already obtained. The table herewith gives the depth of water in column D, from one to forty inches. Column E shows the spouting velocity per second in inches and decimals of an inch—column F the number of cubic feet discharge per minute, for each square inch of opening, under each of the head pressures in column D.

Supposing the opening in the forebay gate to be 48 inches long, as seen at C; and 3 inches wide, as at A or B, and the depth of water D in the forebay, 28 inches. To find the quantity of water discharged, run

TABLE OF
Spouting Velocity.

D	E	F
1	17.64	0.62
2	24.95	0.86
3	30.55	1.16
4	35.28	1.22
5	39.43	1.37
6	43.21	1.50
7	46.68	1.62
8	49.90	1.73
9	52.92	1.84
10	55.79	1.94
11	58.51	2.03
12	61.11	2.12
13	63.61	2.21
14	66.01	2.29
15	68.33	2.37
16	70.57	2.45
17	72.74	2.53
18	74.85	2.60
19	76.90	2.67
20	78.90	2.75
21	80.84	2.81
22	82.75	2.87
23	84.61	2.93
24	86.43	3.00
25	88.21	3.06
26	89.96	3.12
27	91.67	3.18
28	93.35	3.24
29	95.00	3.30
30	96.65	3.35
31	98.22	3.41
32	99.80	3.46
33	101.34	3.52
34	102.87	3.57
35	104.37	3.63
36	105.85	3.67
37	107.31	3.72
38	108.75	3.77
39	110.17	3.82
40	111.58	3.87

down column D until you come to 28 inches; then across to the column F, and you will find (3.24), three and twenty-four hundredths cubic feet of water discharge by an orifice 1 inch square under 28 inch head. The area of the opening, 48 by 3 inches, when multiplied gives 144 square inches; this number multiplied by 3.24 gives (466.56) four hundred and sixty-six and fifty-six hundredths cubic feet, that the opening will discharge per minute. This is the actual and not the theoretical discharge.

Measurement of Water by Miners' Inches.

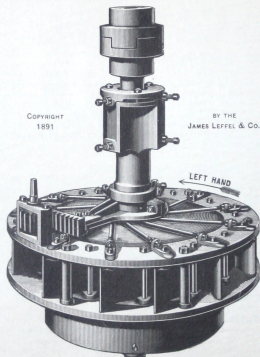
This is another method of measuring a small stream; but a miners' inch in different mining regions does not always measure alike. We may say, however, that one square inch of opening under a head or pressure of 6 inches above the opening, may be taken as a standard of measure. When the opening amounts to a small number of miners' inches, the discharge per minute for each inch will be a trifle less than one and a half cubic feet, but for larger openings, when fifty to a hundred or more inches can be had, the quantity will slightly exceed one and a half cubic feet per minute for each miners' inch. When parties speak of miners' inches, they should give a description of the kind of miners' inch they have in view. The measurement over the opening differs in different mining regions; and each depth or kind of miners' inch will discharge differently. The *six* inch depth is one that is quite generally employed.

James Leffel & Co. (Historical.)

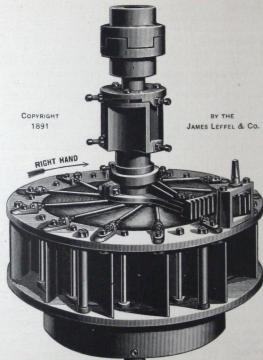
On commencing the manufacture of the James Leffel Wheel, in 1862, two of the present active, prominent and leading members of our firm, bought, set and put into practice, and operated the first complete small iron Leffel Wheel. Immediately after completion of the mill and power plant, driven by this Leffel Wheel, both of said parties became connected with the firm of James Leffel & Co. One of these parties at the same time, becoming equal partner with James Leffel, and was given the general superintendence and management of the manufacture and sale of the wheel, thus placing the business on a thoroughly practical, and successful commercial basis. This member of the firm of James Leffel & Co., originated, designed and made the first sketches and drawings, for the first illustrations used, in showing the principal methods of applying the Leffel Wheel to various kinds of work. This same party is now the head of our concern, and his designs and illustrations just alluded to, are still in our possession, and are the property of our firm and company. We also have his original sketch and tracing of the semi-spiral casing, from which our firm has developed the horizontal shaft Double Discharge type of wheel, now so successfully and so extensively introduced and made by our works.

The James Leffel Water Wheel.

The James Leffel Turbine stands before the public, a thoroughly reliable water wheel, it is no doubtful experiment. The original and present designs have shown under practical test, the greatest economy of water at an average gate opening, also the greatest durability, strength and ease of management. *Thirty-two years* of diligent study and practical



OLD RELIABLE STANDARD.



NEW RELIABLE SPECIAL.

experience in building them, have enabled us to effect the most desirable improvements. Our object has been to produce a wheel by so perfecting its parts, as to keep abreast with the advanced developments of mechanical and hydraulic science.

A common habit of the incompetent is to copy from others, and to imitate that which they are unable to improve or originate themselves. Many makers of other wheels not only imitate our work, but frequently take our printed articles, illustrations, and other matter which we use for describing our wheels and our methods of application. Our forms of tables, which were originated by James Leffel, have been almost universally copied by other wheel manufacturers. Our long and extensive experience in this business affords us every facility for the production of the largest, heaviest, and most complete line of Turbines yet built. We make over *one hundred and forty* different styles and modifications of the James Leffel Wheel, and are supplied with the best and finest line of patterns, and machinery for building this extensive variety.

Our Water Wheel Patents.

We have published in several editions of our pamphlet, a decision and decree of the United States Circuit Court, in a suit instituted by the firm of James Leffel & Co., plaintiffs, against Thos. Leffel & Co., the manufacturers of a so-called Leffel Wheel, who were the defendants. This suit was brought to restrain the said Thos. Leffel & Co. from infringing the patents of the James Leffel wheel. The court fully and completely sustained the James Leffel patents in every particular, absolutely confirming their validity, and a decree was rendered granting an injunction forbidding the manufacture of the said Leffel Wheel by the said Thos. Leffel & Co., who soon afterward went out of business.

We beg to remind those who intend buying water wheels, that the wheel made by James Leffel & Co., is not liable to damages, and other annoyances, that often arise in the use of late patented wheels now on the market, which no doubt in many cases, grossly infringe prior patents. We have issued during the past year several new and important patents, covering improvements that we have recently made on the James Leffel Wheel, notably among which is our new Samson Wheel, and we have a number of other applications pending, for which patents will soon be granted. These are the property of our concern, and we have never given any rights to their use by lease or otherwise, to any other firm engaged in the Water Wheel business. These patents are intended for the protection of our own customers as well as our large and well earned trade.

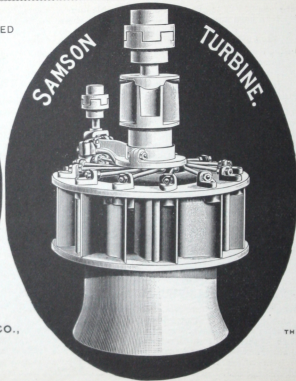
STANDARD and SPECIAL James Leffel Wheels.

The **Old Reliable Standard** is made by our firm, from the designs and drawings, with exact curves, adopted by James Leffel. Our **New Reliable Special** is of equal merit, and is made essentially like the Standard. The only difference is in the adoption of wider gates and wider buckets. This secures an enlarged capacity for water and a largely increased power for the same size Wheel. The apparent difference will be seen in the two styles on page 8, showing wider gates, and more distance between the upper and lower plates for the Special than the Standard. A large number of these are in daily use and after years of operation they have fully proven their excellence for all purposes. They are so

TRADE-MARK, REGISTERED
1893
BY



THE JAMES LEFFEL & CO.,
SPRINGFIELD OHIO.



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1893
BY



THE JAMES LEFFEL & CO.,
SPRINGFIELD OHIO.

nearly a copy of the Standard, that no other assurance of their success would be necessary. We do not rely on this similarity of design, but refer to those long in use.

THE SAMSON TURBINE WATER WHEEL.

THE STRONGEST AND MOST POWERFUL WATER WHEEL NOW BUILT.

The Samson Turbine is a new design of the James Leffel Wheel, upon which we have given much study, time and attention. Over **thirty-two years** experience and practice building the James Leffel Wheel, affords use every opportunity to understand the qualities of a turbine, necessary to meet successfully under all conditions, the present exacting requirements of a water wheel plant. The original design of the Leffel wheel, patented by James Leffel thirty-two years ago, and built by the firm of James Leffel & Co. during this entire time, has established its unquestioned superiority in its economical use of water, its strength and durability, and its general efficiency.

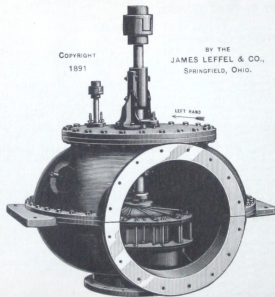
The **Samson Wheel** retains all the valuable features, and excellencies of the old **Reliable** wheel which we have so long built. The **Double Wheel**, which by careful experiments shows its superiority over either wheel separately, and the nice, easily-operated oscillating gates have been retained, to which we have added the **double diameter** feature and a number of other important improvements, for which letters patent have been granted us recently. The new principles of Hydro-Dynamics and Hydraulics discovered in recent years have been carefully studied, and applied to the formation of the curves of our Samson buckets. All of the details of the new design being accurately conformed to the latest and best ideas, and most recent discoveries on the proper form for water wheels.

The **Samson** affords a wonderful amount of power, concentrated in an exceedingly small space, and a far higher velocity than has ever been known heretofore for turbines of the same amount of power. The new design affords a remarkably high economy of water and steadiness of motion under variable gateage. These points of high merit have been carefully and competently ascertained, at great expense by scientific and experimental tests, as well as by practical experience with a large number now in daily operation. The great ease of operating its nicely balanced gate, is an unqualified merit. We guarantee this wheel fully in every particular, even to the extent of a trial if required.

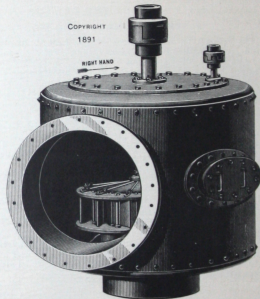
Our **Samson, Special** and **Standard** James Leffel wheels, which we build on both upright and horizontal shafts in a great variety of styles, afford the customer and user an opportunity to obtain a wheel, having the most perfect adaptation to every purpose under any circumstance; a wheel **unequaled in durability, unexcelled in performance.** and **unquestioned in excellence.**

Water Wheel Governors.

The irregular and intermittent powers of various kinds of work, often require a Regulator placed upon the Water Wheel. To secure the greatest uniformity of speed, we supply many of our James Leffel Wheels, with Governors of the best type and highest efficiency. A uniform motion is easily attained on our Leffel Wheel, because of its nicely balanced gate,



Patent Globe Casing.



Improved Cylinder Casing.

IMPROVED IRON CASTINGS FOR JAMES LEFFEL WATER WHEELS.

and its high efficiency in the use of water, whether it is run at a full open or a part gate. Electric light and electric power machinery, demand a much finer regulation, than any other kind of work; and our Wheels and Governors, have proven in every instance highly successful, under the exacting requirements of this character of labor. A high degree of regularity is also frequently found necessary in many other kinds of power, we are therefore called upon to supply Governors, for attaining this desirable result; and are applying them in many cases, especially with horizontal shaft wheels.

Patent Improved Globe Casing.

The left hand of opposite page shows our patent globe casing, in which many of our wheels are now placed. This form secures the greatest strength, the largest space for circulation of water, and occupies less space than any other shape. None of the parts are subject to wear or breakage; hence, it never requires replacing. Our Wheel and its guide casing are built in the usual manner, and are placed inside this casing. Any length of pipe necessary may be attached to this globe. Several illustrations in the pamphlet show such attachments. Often the location of the bulk head is such, that the inlet flange of the casing can be bolted direct to the planking without piping. We prefer to use a short straight tube to connect the globe with the bulk head, placing the wheel in a dryer and more convenient location. A cover is bolted on the top, which can be removed, and the wheel lifted out of the casing, although this is seldom necessary. A man-hole on the side admits of the removal of any obstruction that may by accident get into the casing.

A bridge-tree on the cap carries an oil-bearing for the upper end of the water-wheel shaft. The wheel shaft and gate rod pass through stuffing boxes in the cap plate, preventing any leakage of water, making the whole affair perfectly water tight. It may be found under heads from twenty to three hundred feet. Almost all our smaller wheels are now ordered in this casing. It is not always necessary, except in particular instances, where want of space or other circumstances prevent placing it in a wooden flume. This casing can be easily connected to the head water by pipes of suitable length and size.

Improved Cylindrical Casing. (See page 12.)

The right hand of page 12 shows a style of improved cylindrical casing, that we are making for the larger sizes of wheels. This style has been improved by us from time to time, as experience inclined us to believe became necessary. Many of the points of merit possessed by the Globe casing may be found in this style. It is usually applied under heads much lower, than those under which the Globe is used, and because of the larger size of wheels necessary under low heads it is made of a form and material calculated to secure great strength and circulating space, with the least possible weight.

Instead of suspending it at the center like the Globe, it rests upon sills or masonry placed under its flat bottom. A draft-tube can be attached below, and it is usually best by that means to locate it a short distance above tail water. This casing is provided with a cover, through which the wheel with its guide casing can be removed; a man-hole being also used for occasional examination. It may be located in confined positions, and connected to the bulk-head direct or by piping of suitable length. The shaft and gate rod pass through Stuffing boxes, making both water tight.

Wheel Tables Showing Horse Power, Revolutions and Water Discharged.

The table on opposite page gives the horse power, quantity of water used, and the revolutions per minute while wheels are at labor, of all sizes between $8\frac{1}{4}$ and $17\frac{1}{2}$ inches, under heads from 5 to 44 feet. It will be readily understood by examination. A late peculiarity of our tables, is the style giving the horse power in which we use no fraction where it is possible, and only the common fraction, where fractions cannot be avoided. This is entirely new and original with our company, and lately copyrighted by us, as an improvement in water wheel tables. We believe this will be more readily accepted and understood by our customers, on account of its simplicity, than the usual style with decimals.

Pages 16 and 17, give the powers, etc., of wheels from XXXX 10 inch to 23 inch, under heads from 46 to 210 feet. We prefer to use as large diameter as possible, under these high heads to avoid too great speed; and for that purpose we often reduce the capacity of the Standard to that of much smaller sizes. Pages 18 to 24 are for **Standards**, **Specials** and **Samsons**. The same diameter of wheel coming together, in each of the three styles shown on pages 8 and 10. This new arrangement is ours, and is more concise and easily understood than our former tables.

PRICE-LIST of James Leffel Wheels.

Prices of vertical shaft wheels, will be found in second vertical column of tables, pages 15, 18, 19, 20, 21, 22, 23 and 24. These prices are intended for wheels just as shown on pages 8 and 10, under ordinary heads. The larger wheels being adapted in weight and strength to heads ranging from 6 to 16 feet. The medium sizes to heads of 14 to 30 feet, and the small ones to head pressures of 25 to 50 feet. When lower heads are utilized, the wheels may be made of less weight and strength. If higher heads are used than above named, it is advisable to have the wheels made stronger at additional expense. It is readily understood a wheel may be well adapted in proportion and weight to a 30 foot head, which would be unable to fill the requirements of strength and durability under 120 feet. Where the conditions of power, pressure and kind of work are unusual, we should be consulted and permitted to build the wheel best suited to the situation.

Our smaller wheels are made of bronze, except the guide casing; the gates being made of steel, or bronze, as we may deem best suited to the circumstances. The larger sizes are frequently made with steel gates, for high heads and great strength and power. The **Standard** wheels are the lightest, the **Specials** are *heavier*, and the **Samsons** VERY HEAVY, STRONG and substantially built; the weights increasing almost in the same ratio as the powers, consequently prices are different for same sizes. (See page 25 for condensed price-list.) *Write for Discounts from prices.*

PRICES of Horizontal Shaft Wheels.

Prices of this type of wheel are furnished only on application, after a full knowledge of the kind of work they are intended to do, the amount of power required, and the head pressure under which they will be placed, has been furnished, as these conditions control the style, strength and price. We make more than forty modifications of this type; a number of wheels recently put in operation, each ranging in powers from 900 to 1200 H. P., represent this class of turbines.

New Table Specially arranged for the James' Loffel STANDARD Water Wheels. Copyright 1894, by The James Loffel & Co. 15

Size of WHEEL	Price.	Head in feet 1862	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
10	\$140	Power.. Water.. Speed..		1½ 120 392	1¾ 123 414	2 126 436	2½ 134 457	2¾ 138 473	3 146 497	3½ 152 516	3¾ 158 534	4¼ 163 551	4½ 167 568	5 173 585	5½ 178 601	5¾ 182 617	6¼ 188 632	6½ 191 647	7½ 196 661	7¾ 201 675		
11½	\$145	Power.. Water.. Speed..		1¾ 146 339	2¼ 158 359	2¾ 166 379	3 172 397	3½ 184 415	4 194 432	4½ 202 448	4¾ 206 464	5½ 213 479	5¾ 218 494	6¼ 226 508	7 232 522	7½ 236 536	8¼ 244 549	8½ 248 562	9¼ 254 574	9¾ 260 587		
13¼	\$150	Power.. Water.. Speed..		2¼ 197 294	3 210 312	3½ 221 329	4 230 345	4½ 237 360	5½ 255 375	5¾ 265 389	6¼ 274 403	7¼ 286 416	7¾ 293 429	8½ 303 441	9¼ 307 454	10 316 465	10¾ 323 477	11½ 332 488	12¾ 340 499	13¼ 349 510		
15¼	\$135	Power.. Water.. Speed..		1¾ 202 204	2¼ 224 221	2¾ 246 239	3¼ 257 271	4 281 286	4½ 292 300	5 309 313	5½ 316 326	6¼ 338 350	6¾ 344 352	7¾ 370 373	8¼ 381 384	9 390 394	9¾ 399 405	10¾ 411 414	11½ 421 424	12½ 431 433	13½ 439 443	
17½	\$155	Power.. Water.. Speed..		2¼ 269 176	2¾ 289 193	3¼ 316 208	4 345 223	4½ 360 236	5 379 249	5½ 390 261	6 402 273	6½ 417 284	7 437 295	7½ 451 305	8¼ 463 315	8¾ 484 325	9¼ 497 334	9¾ 509 343	10¾ 524 352	11½ 537 361	12½ 553 369	13½ 564 378
Size of WHEEL	Price.	Head in feet 1862	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
8¾	\$135	Power.. Water.. Speed..	6 151 788	6¾ 155 803	6¾ 157 819	7¼ 159 834	7½ 163 848	7¾ 166 863	8¼ 168 877	8½ 170 891	9 172 905	9½ 176 919	9¾ 178 923	10¼ 180 945	10¾ 183 958	11¼ 186 971	11½ 188 984	12 190 996	12½ 192 1008	13 195 1020	13½ 198 1032	14 201 1046
10	\$140	Power.. Water.. Speed..	8 202 689	8½ 206 703	9 210 716	9½ 214 729	10 218 742	10½ 224 755	11¼ 227 767	11½ 232 780	12¼ 234 792	12¾ 237 804	13¼ 241 816	14 246 827	14½ 250 838	15¼ 252 850	15½ 255 861	16½ 259 872	17 262 882	17½ 266 893	18½ 266 903	18¾ 269 914
11½	\$145	Power.. Water.. Speed..	10½ 265 599	11¼ 270 611	11¾ 275 622	12¼ 282 634	13¼ 286 645	13¾ 293 656	14½ 295 667	15¼ 301 678	16 306 688	16½ 311 699	17¼ 316 709	18¼ 320 719	19 324 729	19½ 328 738	20¾ 332 748	21¼ 336 758	22 339 767	22½ 342 776	23½ 347 785	24½ 352 794
13¼	\$150	Power.. Water.. Speed..	14 353 520	14¾ 361 530	15¼ 368 540	16¼ 376 550	17¼ 381 560	18¼ 387 570	19¼ 395 579	20¼ 401 589	21¼ 407 598	22¼ 413 607	23¼ 419 616	24¼ 425 624	25¼ 431 633	26¼ 436 641	27¼ 442 650	28¼ 446 658	29¼ 453 665	30¼ 459 674	31¼ 464 682	32¼ 470 690
15¼	\$135	Power.. Water.. Speed..	18¼ 461 452	19¼ 471 461	20¼ 480 470	21¼ 488 478	22¼ 495 487	23¼ 505 495	24¼ 509 503	25¼ 521 511	26¼ 528 519	27¼ 536 527	28¼ 545 535	29¼ 553 542	30¼ 560 550	31¼ 569 557	32¼ 575 564	33¼ 582 572	34¼ 589 579	35¼ 595 586	36¼ 602 593	37¼ 610 600
17½	\$155	Power.. Water.. Speed..	23¼ 600 394	24¼ 613 402	25¼ 626 409	26¼ 637 417	27¼ 648 424	28¼ 660 431	29¼ 670 439	30¼ 681 446	31¼ 690 453	32¼ 702 459	33¼ 713 466	34¼ 724 473	35¼ 734 479	36¼ 744 486	37¼ 753 492	38¼ 762 498	39¼ 771 504	40¼ 780 510	41¼ 790 516	42¼ 801 522

Write for DISCOUNTS from these Prices. POWER—Horse Power. WATER—Cubic Feet per Minute. SPEED—Revolutions per Minute.

Size	Head in Feet.	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80	82	84	86	88	90	92	94	96	98	100
XXXX 10	Power	8½	9½	9½	10½	11	11½	12½	12½	13½	14	14½	15½	15½	16½	17	17½	18½	19½	20½	21	21½	22½	23½	24½	25½	26½	26½	27½
	Water Speed	934	956	974	994	1012	1032	1050	1068	1086	1102	1118	1136	1152	1170	1186	1202	1218	1234	1250	1264	1280	1294	1308	1322	1336	1350	1364	1378
XXX 10	Power	11½	12½	13½	14	15	15½	16½	17½	18½	19½	20½	21½	22½	23	24	25	26	27	28	29	30½	31½	32½	33½	34	35½	36½	37½
	Water Speed	934	956	974	994	1012	1032	1050	1068	1086	1102	1118	1136	1152	1170	1186	1202	1218	1234	1250	1264	1280	1294	1308	1322	1336	1350	1364	1378
XX 10	Power	15	16	17	18	19	20	21	22	23	24	25½	27	28½	29½	30½	32	33½	34½	35½	37	38½	40	41½	42½	43½	45	46½	48
	Water Speed	206	210	214	218	222	225	228	231	234	238	243	249	254	258	262	266	269	272	275	278	282	285	289	292	294	296	299	303
STANDARD 10	Power	19½	21	22½	24	25½	27	28½	30	31½	33	34½	36	37½	39½	41½	43	44½	46½	48½	50	51½	53½	55½	57	58½	60½	62½	64
	Water Speed	271	277	284	291	298	304	310	316	321	325	330	334	340	346	352	357	362	367	371	376	380	384	387	391	395	398	401	404
XX 13½	Power	26	28	30	32	34	36	37½	39½	41½	43	45	47	49½	51½	53½	56	58½	60½	62½	65	67½	71½	74	76½	79	82	85	
	Water Speed	357	368	379	388	397	406	411	416	420	424	430	436	444	452	459	465	471	477	483	489	494	499	503	508	514	520	528	537
STANDARD 13½	Power	34	36	39	41½	44½	47	49½	52	54½	57½	60½	63½	66½	69	71½	74½	77½	80	83	86	89½	92½	95½	99	102	106	109	112
	Water Speed	466	479	492	504	518	530	539	547	558	567	579	590	598	605	612	619	625	632	639	647	655	663	672	680	688	697	702	707
STANDARD 15½	Power	45½	48	50½	54	57	60	63½	67	71	75	78½	82	85½	89	92½	96	100	104	108	112	116	120	124	128	132	137	141	146
	Water Speed	621	631	641	653	665	677	690	705	723	740	754	762	771	781	790	799	808	814	821	828	835	842	850	857	864	871	878	885
STANDARD 17½	Power	59½	64	68	72	76	80	84	88	92½	97½	102	107	111	116	121	126	131	136	141	147	153	157	162	168	173	179	184	190
	Water Speed	826	842	859	875	889	902	915	926	945	962	977	993	1005	1018	1033	1047	1061	1074	1085	1100	1114	1127	1140	1154	1163	1178	1189	1200
STANDARD 20	Power	76	81½	86½	91½	96½	103	110	116	122	129	135	141	147	153	160	167	176	186	193	200	207	214	221	228	236	244	252	
	Water Speed	1044	1071	1092	1109	1140	1170	1200	1223	1240	1275	1301	1310	1328	1344	1361	1388	1400	1422	1433	1448	1468	1486	1502	1518	1532	1553	1573	1592
STANDARD 23	Power	104	111	118	125	133	141	149	156	164	172	180	188	196	205	214	222	231	240	249	258	268	277	287	297	307	316	326	336
	Water Speed	1430	1461	1491	1520	1556	1591	1623	1643	1671	1698	1723	1747	1769	1799	1827	1846	1871	1896	1919	1941	1969	1989	2016	2040	2060	2080	2102	2123

Power — Horse-power. Water — Cubic feet per minute. Speed — Revolutions per minute.

The tables on this and the following page, represent the powers, etc., for the smaller sizes of wheels we manufacture, under heads ranging from 44 to 210 feet; the sizes being xxxx 10-inch to 23-inch standard. The xxxx 10-inch is equivalent in power and quantity of water used, to the 6½-inch we formerly built; and the xxxx 10-inch the same in these respects as the 7½-inch; while the xx 10-inch is equivalent to our old 8½-inch. The 10-inch standard is the same as formerly made. The xx 13½-inch being equivalent to the 11½-inch standard. The 13½ inch is usual standard.

New Table arranged for the STANDARD and REDUCED James Leffel Wheels. Copyright 1893, by the James Leffel & Co.

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Size	Head in Feet.	104	108	112	116	120	124	128	132	136	140	144	148	152	156	160	164	168	172	176	180	184	188	192	196	200	204	208	210
XXXX 10	Power	29½	31¾	33¾	35	36¾	39¼	40¼	42¼	44¼	46	48	50	52	54	56	58	60	62¼	64¼	66¾	68½	70¾	73	75¾	78½	81	83½	86
	Water	179	183	187	190	194	197	199	202	205	207	210	213	216	218	220	223	226	228	230	233	235	237	240	244	247	250	252	254
	Speed	1406	1432	1458	1488	1510	1534	1560	1584	1608	1632	1656	1678	1700	1722	1748	1762	1786	1806	1828	1848	1868	1890	1912	1930	1948	1967	1986	2005
XXX 10	Power	40	42½	45	47½	49½	52½	54	57½	60	62½	65½	68½	71	73½	76½	79	81½	83½	85½	88	90½	92½	94½	97	99	101	103	105
	Water	243	248	253	257	262	266	270	274	278	282	287	291	295	298	302	303	305	306	307	308	309	310	311	312	313	314	315	316
	Speed	1406	1432	1458	1488	1510	1534	1560	1584	1608	1632	1656	1678	1700	1722	1748	1762	1786	1806	1828	1848	1868	1890	1912	1930	1948	1967	1986	2005
XX 10	Power	50	53	56	59	62½	65½	69	72½	75½	79	82½	85½	89½	93	96½	100	104	108	112	116	120	124	128	132	136	140	144	148
	Water	303	310	316	321	327	335	340	345	350	356	361	366	371	376	382	387	392	396	402	407	412	416	420	425	429	433	437	441
	Speed	1406	1432	1458	1488	1510	1534	1560	1584	1608	1632	1656	1678	1700	1722	1748	1762	1786	1806	1828	1848	1868	1890	1912	1930	1948	1967	1986	2005
STANDARD 10	Power	68	72	76	80½	85	89	93½	98	102	106	111	116	120	125	130	135	140	145	150	155	160	165	170	175	180	185	190	195
	Water	413	420	428	437	447	454	461	468	474	482	488	495	501	507	513	519	526	532	538	543	548	553	559	565	572	577	582	
	Speed	1406	1432	1458	1488	1510	1534	1560	1584	1608	1632	1656	1678	1700	1722	1748	1762	1786	1806	1828	1848	1868	1890	1912	1930	1948	1967	1986	2005
XX 13¼	Power	89	94	99	104	110	116	121	127	133	139	145	151	157	163	169	176	182	189	196	204	211	218	226	234	241	247	255	262
	Water	545	550	558	565	579	584	598	608	618	627	636	644	652	659	667	678	686	694	705	716	724	732	743	754	765	776	787	
	Speed	1060	1080	1100	1120	1140	1158	1178	1196	1214	1232	1248	1266	1282	1300	1316	1330	1348	1364	1380	1396	1412	1428	1440	1454	1470	1485	1495	1500
STANDARD 13¼	Power	118	125	133	140	147	154	162	169	177	185	193	201	209	218	226	233	240	248	256	265	276	287	299	310	321	329	340	351
	Water	717	731	750	762	774	786	799	810	822	834	847	858	869	880	892	902	910	919	933	948	965	982	999	1017	1034	1052	1070	
	Speed	1060	1080	1100	1120	1140	1158	1178	1196	1214	1232	1248	1266	1282	1300	1316	1330	1348	1364	1380	1396	1412	1428	1440	1454	1470	1485	1495	1500
STANDARD 15¼	Power	154	163	172	181	191	200	211	221	231	241	252	262	272	283	294	303	312	324	336	348	360	374	388	402	416	430	441	454
	Water	935	952	970	987	1005	1023	1041	1057	1073	1089	1104	1118	1130	1145	1161	1167	1173	1180	1206	1231	1256	1277	1295	1314	1332	1350	1367	
	Speed	922	940	956	974	990	1006	1022	1038	1054	1070	1084	1100	1114	1128	1144	1158	1172	1186	1200	1212	1224	1238	1250	1264	1278	1291	1303	1315
STANDARD 17½	Power	201	213	225	237	250	263	276	288	300	316	328	343	356	371	385	400	416	432	448	464	480	499	515	531	547	565	582	600
	Water	1221	1245	1269	1292	1316	1339	1362	1384	1403	1421	1439	1459	1480	1500	1520	1542	1564	1586	1608	1628	1648	1671	1695	1719	1743	1767	1791	
	Speed	804	818	834	852	868	875	892	906	918	932	946	958	972	984	996	1008	1020	1032	1044	1058	1070	1082	1092	1102	1112	1122	1132	1142
STANDARD 20	Power	267	283	298	315	331	348	364	382	400	418	436	454	472	491	509	528	546	565	583	602	620	638	657	675	694	713	732	751
	Water	1632	1656	1681	1712	1743	1770	1797	1827	1858	1885	1913	1937	1962	1987	2010	2031	2054	2073	2093	2111	2129	2145	2162	2180	2198	2216	2234	
	Speed	702	716	730	742	756	768	780	792	804	816	828	839	850	860	872	882	892	902	914	924	934	944	956	966	976	986	996	1006
STANDARD 23	Power	356	377	398	420	442	464	486	509	533	557	580	605	630	655	680	706	734	760	784	812	840	868	896	924	952	980	1008	1036
	Water	2163	2206	2247	2288	2332	2358	2386	2417	2475	2514	2548	2583	2618	2653	2686	2720	2750	2782	2821	2851	2884	2925	2955	2991	3021	3051	3081	3111
	Speed	612	622	634	646	656	667	678	688	700	710	720	729	738	748	758	768	778	788	797	806	815	824	833	842	851	860	869	878

RIGHT HAND

WATER WHEEL

LEFT HAND



Power — Horse-power. Water — Cubic feet per minute. Speed — Revolutions per minute.

The tables on these pages are entirely, and essentially new in several features. Heretofore our style and character of table, as originated by James Leffel, has been almost universally copied by other wheel manufacturers. Our new arrangement omits entirely, where possible, the fractional parts of horse powers; when fractions are retained, instead of decimals, we have inserted the simple, proper fraction. This style of fractional horse power will be easily comprehended by the general reader and correspondent, being decidedly more practical, and on that account preferable.

New Table Specially arranged for STANDARD, SPECIAL and SAMSON Water Wheels. Copyright 1894, by The James Leffel & Co. 19

Size of WHEEL	Price.	Head in feet	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
STANDARD 20	\$180	Power	29 3/4	31 1/4	33 1/4	35 1/4	37 1/4	39 1/4	41 1/4	43 1/4	45 1/4	47 1/4	50	52 1/4	54 1/4	56 1/4	59 1/4	61 1/4	63 1/4	66 1/4	68 1/4	71	73 1/4
		Water Speed	780	796	814	831	846	861	874	887	901	914	929	943	957	970	983	996	1009	1021	1032	1043	1056
SPECIAL 20	\$200	Power	43	45 1/4	48 1/4	51 1/4	54 1/4	57 1/4	60 1/4	63	66 1/4	69 1/4	72 1/4	75 1/4	79	82 1/4	85 1/4	89 1/4	92 1/4	96	99 1/4	103	106 1/4
		Water Speed	1131	1154	1180	1204	1226	1248	1267	1286	1306	1325	1347	1367	1387	1406	1425	1444	1463	1480	1496	1512	1531
SAMSON 20	\$250	Power	74 1/4	79 1/4	84 1/4	89	94	99 1/4	104	109 1/4	115	120	126	131 1/4	137	142 1/4	148	155	161	166	172	179	185
		Water Speed	2007	2049	2089	2129	2168	2206	2244	2281	2318	2354	2389	2424	2458	2492	2526	2559	2591	2629	2656	2687	2718
STANDARD 23	\$210	Power	39 1/4	42	44 1/4	47 1/4	49 1/4	52 1/4	55 1/4	58	61	63 1/4	66 1/4	69 1/4	72 1/4	75 1/4	78 1/4	82	85 1/4	88 1/4	91 1/4	94 1/4	98 1/4
		Water Speed	1040	1062	1086	1106	1126	1144	1164	1182	1206	1221	1241	1259	1270	1293	1311	1329	1345	1360	1377	1392	1411
SPECIAL 23	\$235	Power	57 1/4	61	64 1/4	68 1/4	72	76	80	84	88	92	96 1/4	101	105 1/4	110	114 1/4	119	123 1/4	128	132 1/4	137	142
		Water Speed	1597	1539	1574	1603	1633	1659	1688	1715	1738	1767	1798	1826	1852	1877	1902	1926	1949	1973	1992	2013	2039
SAMSON 23	\$270	Power	98 1/4	105	111	118	124	131	138	145	152	159	166	174	181	189	197	204	212	220	228	236	245
		Water Speed	2655	2699	2763	2816	2867	2918	2968	3024	3065	3113	3160	3206	3251	3296	3340	3384	3429	3470	3512	3553	3595
STANDARD 26 1/2	\$250	Power	51 1/4	54 1/4	58	61 1/4	64 1/4	68 1/4	72	75 1/4	79 1/4	83	86 1/4	90 1/4	94 1/4	98 1/4	102 1/4	106 1/4	110	115	119	123 1/4	127 1/4
		Water Speed	1356	1384	1410	1436	1458	1487	1512	1539	1565	1589	1612	1634	1659	1682	1705	1726	1750	1772	1790	1811	1835
SPECIAL 26 1/2	\$275	Power	74 1/4	79 1/4	84	89	94	99	104 1/4	109 1/4	115	120 1/4	125 1/4	131 1/4	137	142 1/4	148 1/4	154 1/4	160 1/4	166 1/4	172 1/4	178 1/4	185 1/4
		Water Speed	2003	2045	2083	2122	2157	2201	2232	2271	2305	2333	2370	2405	2434	2470	2503	2536	2564	2596	2627	2661	
SAMSON 26 1/2	\$310	Power	131	139	148	156	165	174	183	192 1/4	202	211	221	231	241	251	261	271	282	292	303	314	325
		Water Speed	3525	3597	3669	3738	3807	3874	3941	4006	4070	4133	4195	4256	4316	4376	4435	4493	4550	4605	4663	4717	4772
STANDARD 30 1/2	\$290	Power	68 1/4	73	77 1/4	81 1/4	86 1/4	91	96	100 1/4	105 1/4	110 1/4	115 1/4	121	126	131 1/4	136 1/4	142	147 1/4	153			
		Water Speed	1804	1845	1878	1913	1952	1983	2022	2049	2083	2116	2151	2185	2212	2242	2274	2301	2330	2358			
SPECIAL 30 1/2	\$315	Power	99 1/4	106	112	118	125	132	139 1/4	145 1/4	153	160	167 1/4	175 1/4	182 1/4	190 1/4	198	206	214	222			
		Water Speed	2614	2679	2722	2774	2821	2870	2933	2971	3022	3064	3118	3169	3208	3249	3293	3338	3381	3422			
SAMSON 30 1/2	\$370	Power	173	184	196	207	218	230	242	255	267	280	293	306	319	332	346	360	374	387			
		Water Speed	4669	4859	4954	5043	5132	5220	5306	5391	5475	5557	5638	5718	5797	5875	5953	6027	6102				



Write for DISCOUNTS from these Prices. POWER—Horse Power. WATER—Cubic Feet per Minute. SPEED—Revolutions per Minute.

20 New Table Specially arranged for STANDARD, SPECIAL and SAMSON Water Wheels. Copyright 1894, by The James Leffel & Co.

Size of WHEEL	Price	Head in feet	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
STANDARD 35	\$330	Power	3	5 1/8	8 1/8	11 1/8	14 1/8	17 1/8	20 1/8	24 1/8	28	32	36	40 1/8	44 1/8	49	54	58 1/8	63 1/8	68 1/8	74	79 1/8	84 1/8
		Water Speed	852 72	963 80	1074 88	1185 96	1289 104	1382 111	1457 118	1532 125	1609 132	1685 142	1750 148	1817 153	1875 158	1935 162	2007 167	2063 172	2120 177	2172 180	2227 185	2276 188	2329 189
SPECIAL 35	\$350	Power	4	8 1/8	12 1/8	16 1/8	20 1/8	25 1/8	30	35	40 1/8	46 1/8	52 1/8	58 1/8	64 1/8	71	78 1/8	85 1/8	92 1/8	99 1/8	107 1/8	115	122 1/8
		Water Speed	1176 72	1370 80	1584 88	1758 96	1862 104	2004 111	2115 118	2220 125	2353 132	2442 136	2541 142	2635 148	2717 153	2804 158	2909 162	2989 167	3072 172	3148 177	3227 180	3303 185	3366 189
SAMSON 35	\$455	Power	10 3/8	15 1/8	22 1/8	29 3/8	36 3/8	45	53 3/8	62 3/8	72 3/8	82 3/8	93 1/8	104	115	127	139	152	165	178	191	205	219
		Water Speed	2224 77	2508 88	2872 96	3146 104	3398 112	3632 118	3853 125	4060 132	4259 140	4449 148	4630 153	4805 158	4974 165	5137 172	5295 177	5449 183	5598 188	5743 193	5885 198	6024 205	6159 208
STANDARD 40	\$375	Power	3	7	11	15	19	23	27	32	37	42	47 1/8	53	58 1/8	64 1/8	70 7/8	77	84	90	97	104	111 1/8
		Water Speed	722 61	1106 69	1390 77	1580 84	1715 91	1817 97	1896 103	2022 109	2125 114	2212 119	2302 124	2382 129	2464 133	2547 138	2620 142	2703 146	2794 150	2884 154	2970 158	3057 162	3057 165
SPECIAL 40	\$400	Power	4	10	16	21 1/8	27	33	39	46	53	61	69	77	85	93	102	111	121	131	141	151	161 1/8
		Water Speed	1138 61	1580 69	2022 77	2264 84	2439 91	2607 97	2738 103	2907 109	3045 114	3212 119	3354 124	3476 129	3581 133	3672 138	3792 142	3897 146	4024 150	4139 154	4243 158	4337 162	4437 165
SAMSON 40	\$565	Power	13 1/8	20 3/8	28 3/8	37 1/8	46 3/8	57 1/8	68 1/8	80 1/8	92 1/8	105 1/8	121	139	148	158	178	194	210	227	244	262	280
		Water Speed	2539 67	3278 77	3665 86	4015 95	4336 102	4630 110	4917 116	5183 122	5436 129	5678 134	5910 139	6133 145	6348 150	6557 155	6758 160	6954 165	7145 169	7330 173	7511 177	7706 182	7861 186
STANDARD 44	\$415	Power	6	9 1/8	13	17	22	27	32	37	43	49	55	61 1/8	68 1/8	75	82 1/8	90	98	108	117	125	134
		Water Speed	1359 56	1501 63	1643 70	1790 78	1986 83	2133 89	2247 94	2338 100	2470 104	2580 109	2673 114	2776 118	2865 122	2962 126	3067 130	3160 134	3259 137	3412 141	3521 145	3590 148	3682 151
SPECIAL 44	\$450	Power	9	14	19	25	32	39	46 1/8	54	62	71	80	89	98 1/8	109	119	130	142	155	169	181	194
		Water Speed	2033 56	2213 63	2401 70	2633 78	2869 83	3081 89	3265 94	3412 100	3562 104	3739 109	3889 114	4017 118	4150 122	4305 126	4424 130	4504 134	4723 137	4898 141	5086 145	5199 148	5330 151
SAMSON 45	\$700	Power	16 1/8	25 1/8	35 3/8	47 1/8	59 3/8	72 3/8	86 1/8	101	117	133	150	168	187	205	225	245	266	287	309	332	355
		Water Speed	3593 60	4130 68	4939 78	5081 85	5488 92	5868 98	6224 104	6560 109	6880 115	7186 120	7480 125	7762 130	8018 134	8298 138	8554 143	8802 147	9043 151	9278 155	9507 158	9731 162	9949 166
STANDARD 48	\$480	Power	7 1/8	11 1/8	16	21 1/8	27	33	39	46	53	60 1/8	68 1/8	76	84 1/8	93	102	111	120	130	140	150 1/8	161
		Water Speed	1596 48	1824 56	2022 63	2260 69	2437 74	2607 80	2738 85	2907 89	3045 94	3186 97	3305 101	3430 105	3560 109	3670 113	3792 117	3897 121	3991 124	4108 127	4213 130	4323 133	4424 136
SPECIAL 50	\$580	Power	11 1/8	18 1/8	25	33	42	51	61	71 1/8	82	94	106	118	131	144	157	171	185	200	216	232	248
		Water Speed	2422 48	2844 56	3160 63	3476 69	3792 74	4029 80	4283 85	4518 89	4711 93	4950 97	5153 101	5326 105	5519 109	5688 113	5836 117	6004 121	6153 124	6320 127	6500 130	6664 133	6814 136
SAMSON 50	\$860	Power	20 3/8	32 1/8	44 1/8	58 1/8	73 1/8	89 1/8	107	125	145	165	186	207	230	254	278	303	329	355	382	409	438
		Water Speed	4336 53	5123 62	5727 69	6274 76	6776 82	7245 87	7684 93	8099 98	8495 102	8873 107	9235 111	9584 116	9920 120	10245 124	10585 128	10867 131	11165 135	11455 138	11738 142	12014 145	12284 148

Write for DISCOUNTS from these Prices. POWER—Horse Power. WATER—Cubic Feet per Minute. SPEED—Revolutions per Minute.

New Table Specially arranged for STANDARD, SPECIAL and SAMSON Water Wheels. Copyright 1894, by The James Leffel & Co. 21

Size of WHEEL	Price.	Head in feet	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44			
STANDARD 35	\$330	Power Water Speed	90 1/2 2376 193	96 2427 197	102 2475 201	107 3/4 2522 205	113 1/4 2567 208	120 2615 212	126 1/4 2660 216	132 1/4 2706 220	139 2745 223	145 3/4 2791 226	152 1/4 2830 230	159 2871 233	166 2914 236	173 2955 240	180 2993 243	187 3030 246	194 1/4 3069 249	201 1/4 3110 252	209 3145 255	216 1/2 3182 259	224 3217 262			
SPECIAL 35	\$350	Power Water Speed	131 3446 193	139 1/4 3520 197	148 3597 201	156 1/4 3657 205	165 3724 208	174 3792 212	183 3855 216	192 1/4 3919 219	202 3984 223	211 1/4 4041 226	220 4089 230	230 4153 233	240 4213 236	250 4270 240	261 4326 243	271 4381 246	281 4440 249	292 4501 252	303 4559 255	313 4600 259	324 4654 262			
SAMSON 35	\$455	Power Water Speed	234 6292 217	249 6421 222	264 6548 226	279 6673 230	295 6796 235	311 6916 239	327 7034 243	343 7150 247	360 7265 251	377 7379 255	394 7488 258	412 7598 262	430 7706 266	447 7812 269	466 7917 273	485 8020 277	504 8122 280	522 8222 283	541 8323 287	560 8421 290	580 8519 294			
STANDARD 40	\$375	Power Water Speed	118 1/4 3127 169	126 3185 172	133 1/4 3251 176	141 1/4 3312 179	149 1/4 3374 182	157 1/4 3437 186	166 3497 189	174 1/4 3552 192	182 1/4 3609 195	191 1/4 3662 198	200 3717 201	209 3773 204	218 3827 207	227 1/4 3876 210	236 1/4 3933 212	245 1/4 3982 215	255 1/4 4032 218	265 4086 220	275 1/4 4140 223	286 4194 225	296 4248 228			
SPECIAL 40	\$400	Power Water Speed	172 4529 169	183 4626 172	194 4715 176	205 1/4 4810 179	217 4898 182	228 1/4 4979 186	240 1/4 5056 189	252 1/4 5147 192	265 5233 195	277 1/4 5314 198	290 5390 201	303 5471 204	316 5547 207	329 1/4 5628 210	343 5704 212	356 1/4 5777 215	370 5846 218	383 1/4 5907 220	397 5968 223	411 6029 225	424 6090 228			
SAMSON 40	\$565	Power Water Speed	298 8030 190	317 8196 194	336 8358 197	356 8517 201	376 8674 205	396 8827 209	417 8978 212	438 9127 216	459 9272 219	481 9416 222	503 9558 226	526 9697 229	548 9835 233	571 9971 236	594 10105 239	618 10237 242	642 10366 245	665 10504 248	691 10630 251	718 10754 254	746 10870 257			
STANDARD 44	\$415	Power Water Speed	143 3765 155	152 3842 158	161 3913 161	170 1/4 3990 164	180 4062 167	190 4140 170	200 4213 173	210 4281 176	220 4345 178	230 4404 181	240 1/2 4470 184	251 4532 187	262 4599 189	273 4663 192	284 4723 194	295 1/4 4782 197	307 4850 200							
SPECIAL 44	\$450	Power Water Speed	207 5451 155	220 5561 158	233 1/4 5675 161	247 5781 164	261 5891 167	275 5993 170	290 6100 173	304 1/4 6207 176	316 6323 178	332 6438 181	348 6548 184	364 6671 187	380 6774 189	396 6874 192	412 6954 194	428 7035 197	448 7118 200							
SAMSON 45	\$700	Power Water Speed	378 10164 169	402 10350 173	426 10579 176	451 10805 180	476 10978 183	502 11172 186	528 11363 189	555 11551 192	582 11736 195	609 11918 199	637 12097 202	665 12246 205	694 12448 207	723 12620 210	753 12789 213									
STANDARD 48	\$480	Power Water Speed	171 1/4 4516 139	182 4600 142	193 1/4 4697 144	204 1/4 4786 147	216 4875 150	227 1/4 4957 153	240 5056 155	252 5137 157	264 5214 160	276 1/4 5295 163	289 5372 165	302 5453 168	315 5530 170	STANDARD, SPECIAL and SAMSON JAMES LEFFEL WHEELS BUILT BY THE JAMES LEFFEL & CO., SPRINGFIELD, OHIO, U. S. A.										
SPECIAL 50	\$580	Power Water Speed	264 6952 139	280 7078 142	297 7219 144	315 7372 147	332 7493 150	350 7627 153	369 7740 155	388 7910 157	407 8038 160	426 8158 163	445 8271 165	465 8306 168												
SAMSON 50	\$860	Power Water Speed	466 12548 152	496 12807 155	526 13060 158	557 13309 161	588 13553 164	620 13793 167	652 14029 169	685 14261 172	718 14456 175	752 14714 178	786 14935 180													

Write for DISCOUNTS from these Prices. POWER—Horse Power. WATER—Cubic Feet per Minute. SPEED—Revolutions per Minute.

22 New Table Specially arranged for STANDARD, SPECIAL and SAMSON Water Wheels. Copyright 1894, by The James Leffel & Co.

Size of WHEEL	Price.	Head in feet 0"	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
STANDARD 56	\$700	Power Water Speed	13 2738	20 3160	28 3539	36½ 3844	46 4153	56 4424	67 4704	78 4929	90 5171	103 5423	116 5649	129½ 5846	143½ 6045	158 6241	173 6431	189 6636	205 6818	221 6983	238 7162	255 7325	273 7501	291 7663
SPECIAL 56	\$750	Power Water Speed	15 3160	23 3634	32½ 4108	42 4424	53 4785	65 5135	78 5477	91 5751	104 5975	119 6267	135 6563	150 6771	166 6994	183 7228	200 7435	216 7689	232 7916	249 8080	266 8306	283 8503	300 8683	317 8874
SAMSON 56	1050	Power Water Speed	25½ 5564	39½ 6425	55½ 7184	73½ 7869	92½ 8500	112 9089	134 9638	157 10137	182 10646	207 11130	233 11584	261 11994	289 12415	318 12822	349 13247	380 13631	412 14005	445 14368	479 14724	514 15070	549 15409	585 15740
STANDARD 61	\$800	Power Water Speed	15 3160	23½ 3713	33 4171	43 4519	54 4875	66 5214	79 5549	92 5814	106 6090	121 6372	137 6660	153 6906	170 7162	187 7386	205 7621	223 7829	242 8049	261 8247	280 8426	300 8618	321 8820	342 9006
SPECIAL 61	\$850	Power Water Speed	18 3792	27 4266	38 4803	50 5266	62 5597	76 6004	90 6320	106 6699	123 7066	140 7373	159 7729	177 7990	197 8300	217 8571	237 8810	258 9058	281 9346	302 9543	324 9750	347 9997	372 10221	397 10454
SAMSON 62	1270	Power Water Speed	31½ 6821	48½ 7876	68½ 8806	89½ 9648	113 10396	138 11114	165 11815	193 12454	223 13062	254 13612	286 14199	320 14736	355 15253	391 15753	428 16238	466 16709	505 17127	546 17572	587 18048	629 18472	673 18888	717 19294
STANDARD 66	\$905	Power Water Speed	18 3792	28 4424	39 4929	51 5372	64½ 5823	79 6241	95 6671	111 7015	128 7354	146 7689	164 7972	183 8261	203 8553	224 8848	245 9108	267 9374	290 9646	313 9890	336 10112	361 10370	386 10606	411 10823
SPECIAL 66	\$975	Power Water Speed	26 4213	40 5056	44 5561	47 6109	50 6590	54 7110	58 7584	63 7963	68 8378	72 8742	75 9091	78 9389	80 9732	82 10072	85 10372	87 10676	89 10976	91 11276	95 11527	97 11806	100 12090	102 12350
SAMSON 68	1520	Power Water Speed	38 8285	58½ 9474	82 10594	108 11604	136 12534	166 13400	198 14213	232 14981	268 15712	305 16411	344 17081	384 17726	426 18348	470 18950	515 19533	561 20099	608 20603	656 21186	706 21710	757 22221	809 22720	863 23208
SPECIAL 74	1250	Power Water Speed	24 32	38 37	53 37	70 41	88 45	108 53	130 59	152 62	175 65	199 67	225 67	251 67	275 72	306 74	336 77	366 79	397 81	430 83	465 85	500 87	535 89	570 91
SAMSON 74	1800	Power Water Speed	45½ 9717	69½ 11221	97½ 12545	128 13742	161 14843	197 15869	235 16832	275 17741	317 18607	361 19435	407 20227	455 20992	505 22441	556 23132	609 24455	664 25090	720 25710	777 26314	836 26914	896 27510	956 28090	1016 28650
SPECIAL 87	1625	Power Water Speed	36 7584	54 8532	77 9734	101 10638	126 11376	155 12245	186 13061	217 13714	251 14421	285 15010	322 15653	360 16251	400 16853	444 17380	482 17999	525 18433	569 18926	615 19434	659 19832	706 20314	757 20773	809 21214

Write for DISCOUNTS from these Prices. POWER—Horse Power. WATER—Cubic Feet per Minute. SPEED—Revolutions per Minute.



CONDENSED PRICE LIST.

SIZES.	8 $\frac{1}{4}$	10	11 $\frac{1}{8}$	13 $\frac{1}{4}$	15 $\frac{1}{4}$	17 $\frac{1}{2}$	20	23	26 $\frac{1}{4}$	30 $\frac{1}{4}$	35	40	44	45	48	50	56	61	62	66	68	74	87
STANDARD	\$135	\$140	\$145	\$150	\$155	\$155	\$180	\$210	\$250	\$290	\$330	\$375	\$415		\$480		\$700	\$800		\$905		\$1180	\$1550
SPECIAL							\$210	\$235	\$275	\$315	\$350	\$400	\$450			\$580	\$750	\$850		\$975		\$1250	\$1625
SAMSON							\$250	\$270	\$310	\$370	\$455	\$565		\$700		\$860	\$1050		\$1270		\$1520	\$1800	
GLOBE CASES	\$80	\$85	\$90	\$100	\$115	\$130	\$150	\$175															

The foregoing prices are for Water Wheels and Globes, shown on pages 8, 10 and 12; for heads as described under general price list on page 14. The SAMSON Wheels weigh almost TWICE as much as Standards, hence their higher price.

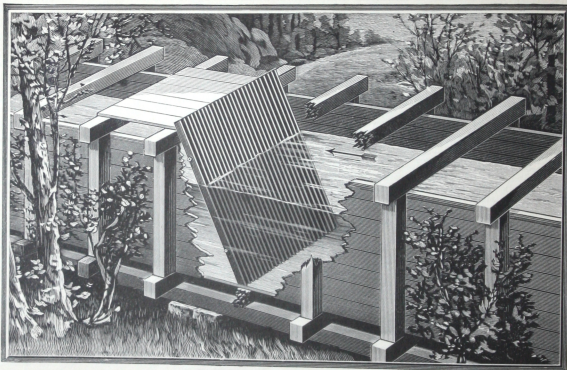
Liberal discounts made from this price-list.

Globe Cases are made for Wheels below 23 inch Standard and Special, but no Globes are made for Samson Wheels. CYLINDER CASES are made for STANDARDS, SPECIALS and SAMSONS from 20 inches upward, including all the larger sizes. They are made for Standard and Special Wheels of the same size and dimensions, but for Samson Wheels, they are made much heavier and stronger, with larger inlets that the water may enter slowly, avoiding much of the loss of power resulting from friction by high velocities, when small inlets are used. Prices are always quoted on Cylinder Cases, after knowing the head under which the wheel operates. Pages 12 and 13 give illustrations and descriptions.

VENT and DISCHARGE of Turbine Wheels.

The bucket openings of Turbines and common openings, not connected with Water Wheels, although measuring the same number of square inches, discharge different quantities of water under the same heads. The discharge is not seriously retarded, in the chutes of a well constructed Turbine; however, when a wheel is introduced into a casing, and the water is admitted to the buckets, after passing the guides or chutes, a large decrease of velocity occurs, and consequently a decrease of discharge; because the water has to pass the guide openings, and the bucket openings one after the other. This subject is fully discussed on page 33 of our 1893 pamphlet.

It is therefore a common practice of Turbine builders, to adopt a theoretical opening, which they call "vent," equal in discharge to that of an unobstructed orifice. This vent does not represent the full amount of opening of the buckets or of the chutes. Turbines usually discharge one-half to eight-tenths of the water that would flow through a common opening or a well constructed chute, where no wheel interferes. On account of the confusion and misunderstanding of the proper meaning of vent, by the usual purchaser, we omit the square inches vent entirely in this pamphlet; but we give in the tables the exact quantity of water, that each wheel will actually discharge, under different working heads.



FOREBAY RACK AND SCREEN.

Forebay Rack or Screen.

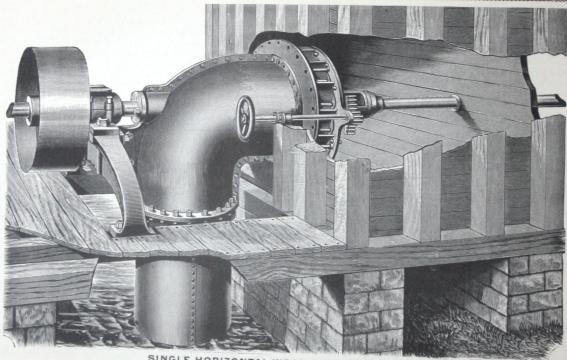
Any kind of water wheel, whether Overshot, Hurdy Gurdy or Turbine, requires a screen to prevent floating obstructions passing into the gates and wheel. This is necessary with a Turbine because of the liability to choke, and to break or injure the guides or the wheel buckets. The opening of our wheel guides and buckets is so large that it is less liable to the difficulty of choking when unprotected, and its work not so easily interrupted, as many other kinds of Turbines. We invariably insist in all cases upon the use of one or more well constructed racks or screens, in the forebay, or at the mouth of the head pipe, as a necessary precaution at all times against drift, leaves or other floating matter. The opposite page shows one of the simpler methods of constructing and placing a rack. It may be made of thin pieces of iron or wood; iron is preferred as the pieces can be thinner than wood, occupying much less space, admitting of larger water passages. The cheapest and simplest arrangement of these pieces, whether iron or wood, is to place them side by side in a line, each piece having two or more holes, so the holes in the several pieces will all be in line, through which a small iron rod can pass with nuts on each end. Upon this rod, and between each piece, an iron or wood washer of proper thickness, can be placed, thereby affording space for the water to pass through towards the wheel. The larger wheels admit of heavier slats, and coarser spaces between them. Where two or more racks are used, the furthest one up stream may have large spaces, as this one will catch most of the heavy drift; and lessen the labor and attention to the finer racks nearer the wheel. Two racks are a sufficient number; but whatever kind is adopted, they should have frequent attention, and should be cleaned to prevent the loss of head, which would occur if they were neglected.

When using small Turbines, finer racks are necessary, than with large wheels. A coarse brass wire screen affords an excellent arrangement; as this material does not rust in water, and is very durable. Wheels up to 15 inches in diameter, should have the meshes in this wire screen from three-eighths to five-eighths, or three-quarters of an inch square. The cross section of the flume, or forebay, in all cases should be amply large, where the rack or screen is placed, for the free and easy passage of water, should the rack become at any time partly clogged. Care must be exercised to keep the rack and wheels clean, to prevent loss of head by obstructing the rack. By keeping obstructions out the wheel, its durability and successful performance is greatly increased. We are prepared to furnish parties using wheels, with racks or screens.

Three Thousand Testimonials.

During our 32 years experience building the James Leffel Wheel, there have accumulated and are now on file in our office, no less a number of complimentary letters than the above mentioned number. Our various editions of pamphlets, have contained from time to time, a large number praising the good qualities, and successful performance of our Turbine. There has not been sufficient space to publish more than a small portion of those in our possession, and this edition of pamphlet will contain even a less number than usual.

Smith & Jackson, Baldwin, Michigan.—“The 40-inch Special bought of you is giving the best of satisfaction, driving all the machinery of a complete 80 barrel mill, under 8½ ft. head at three-fourths gate.” (*Flouring Mill.*)



SINGLE HORIZONTAL WOOD PENSTOCK WHEEL.

Single Horizontal Wood Penstock Wheel.

The foregoing page gives a position of wheel which is occasionally convenient, and affords a very efficient plan for a direct connection of power to almost any kind of machinery. The bottom plate of the guide casing is placed against the side planking on the inside of the wood penstock, and to this plate is attached a curved draft tube, the lower portion of which extends down to the tail-water, and is submerged sufficiently to prevent the air entering and passing up the tube, displacing head-pressure.

The shaft extends through a stuffing-box, and is supported by an iron bridge-tree at any convenient distance from the tube, and upon this any size and number of pulleys may be placed. The shaft can be extended on the opposite side of penstock if necessary, and pulleys attached on that side. Care should be exercised in placing this in a rigid and horizontal position, and using a good stuffing-box in the planking, to prevent leakage.

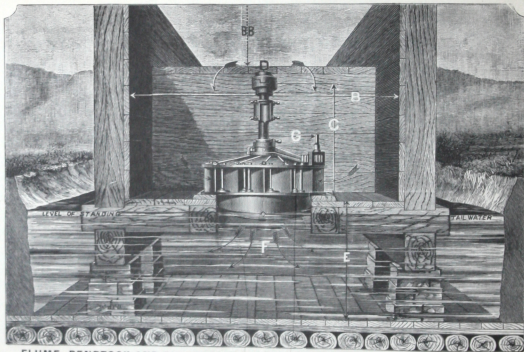
Revolutions of Water Wheels while at Labor.

The speed of the wheels in the tables, are the number of revolutions they should make when at actual work. These speeds are intended for the use of parties when estimating the speed the machinery should have while doing work. The speed of the wheel if operating under a full open gate, and without any work thrown upon it, would be considerably greater than that in the tables. Actual practice always shows a loss of head by the lowering or drawing down of the water in the head-race, and filling up or rising in the tail-race when the wheel is running; and those having charge of constructing the work, and putting in the wheels, should make some reduction for this loss of head, in calculating the speed of the wheel and machinery, to be connected together.

Narrow and shallow head-races and tail-races, incur greater loss than those of larger dimensions. The lower the head the greater care should be exercised in obtaining all of the head that the circumstances will permit. The loss of head under the lower falls is less than under the higher heads, usually 6 to 15 inches loss occurs with low and medium heads, and from a foot to two feet with medium to high heads, under ordinary conditions. It is always advisable in estimating the speed, to make some allowance for the reduction of head from the causes named. There are other variations frequently caused by variable stages of water, occurring at different seasons of the year, and sometimes by neighboring mills, that should have a bearing on the question of exact head.

W. L. McCoy, Meadowfield, Tenn. "I am using a 13 $\frac{1}{4}$ inch Leffel Wheel to drive a 25 barrel roller mill on wheat, and one buhr on corn. Don't think there could be a better wheel built."

Geo. Overshire, Bellevue, Mich. "I am well pleased with the 40 inch wheel purchased of you. Running under 10 ft. head with one-fourth gate; did run last summer under 5 ft. at three-quarter gate; am running four double stand of rolls and machinery necessary to make a complete mill, also corn sheller." (*Flouring Mill.*)



FLUME, PENSTOCK AND PIT ARRANGEMENT FOR STANDARD AND SPECIAL WHEELS.

Table of Wheel and Penstock Dimensions.

NOTE.—All measurements are given in inches.

A—Diameter of *Standard* and *Special* Water Wheels.

A A—Diameter of entire Water Wheel.

B—Size of square or rectangular Penstock where wheel sets; and width of flume leading water to wheel.

BB—Depth of water flowing in flume leading to wheel.

C—Shaft from floor of penstock to center of coupling.

D—Diameter of bore of upper half coupling.

E—Depth of pit from floor where wheel sets to floor of pit, when the water discharges at one side.

EE—Depth of pit from floor where wheel sets to floor of pit, when the water discharges at two sides.

F—Diameter of hole in floor of flume for wheel cylinder.

G—Distance between centers of gate rod and wheel shaft.

H—Diameter of cylindrical wood penstock containing water wheel.

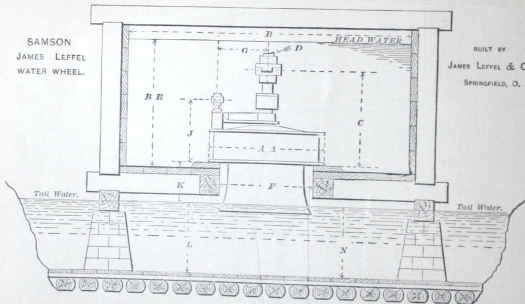
I—Diameter of round, short, wood pipes feeding cylindrical wood penstocks.

The illustration on page 28, and dimensions in this table, apply to both *standard* and *special* wheels. The measurements for the inflowing water, the size of penstock where wheel rests, and the outflowing water at pit, have been estimated upon a basis of a loss of three to four per cent. of the head when using the *specials*. If parties desire a slower speed for entrance and discharge water, and wish to prevent a part of the loss of head taken into account above, they can adopt larger dimensions for the flume, penstock and pit, thereby reducing the velocity and friction of the water before and after acting upon the wheel. We do not think it advisable to construct the work with less space dimensions than we have given in this table for the use of the *special* wheels.

A	AA	B	BB	C	D	E	EE	F	G	H	I
10	15	24	8	16	1½	24	24	13	6½	24	14
11½	16	24	9	17	1½	24	24	14	7¼	26	16
13¼	19	24	10	18	1¾	24	24	17	8½	28	18
15¼	22	28	12	22	1¾	26	26	18	10¾	30	20
17½	25	32	14	25	2	28	28	21	11¾	36	24
20	28	36	18	28	2½	30	30	23	13¾	40	28
23	33	42	24	35	2¾	32	32	27	14¾	50	36
26½	38	48	28	38	2¾	36	36	31	17¼	58	42
30½	43	56	30	40	3½	40	36	35	19¾	66	48
35	49	64	36	44	4¾	44	38	40	22¼	76	56
40	57	74	42	46	4¾	48	40	45	25¼	84	64
44	60	80	46	50	4¾	52	40	50	27¾	92	70
48	68	84	50	57	5¾	52	42	53	31½	94	76
50	69	94	54	63	5¾	60	44	55	32½	104	82
56	79	104	58	68	5¾	64	46	62	36	120	90
61	83	118	66	68	5¾	70	48	67	37½	130	96
66	89	136	72	70	5¾	74	50	72	40½	138	106
74	100	150	76	75	6	80	52	80	46	160	114
87	118	168	94	82	6½	96	54	95	53¼	180	138

SAMSON
JAMES LEFFEL
WATER WHEEL.

BUILT BY
JAMES LEFFEL & CO.
SPRINGFIELD, O.



DIMENSION CUT OF SAMSON WHEEL, PENSTOCK AND PIT.

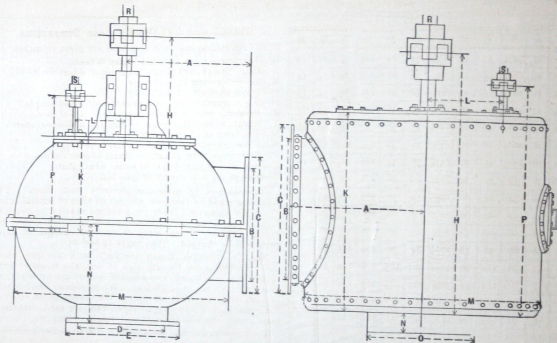
Table of SAMSON Wheel. Penstock, and Flume Dimensions. See illustration.

A	Size of SAMSON Wheels	20	23	26	30	35	40	45	50	56	62	68	74
AA	Diameter of casing. (All dimensions in this table are given in inches)....	30	34	38	43	48	55	62	70	78	85	92	100
B	Size of square penstock and breadth of feeding flume leading to wheel....	45	52	60	68	78	88	100	110	123	137	150	164
BB	Depth of water in feeding flume leading to wheel.....	44	48	54	58	62	68	76	82	88	98	104	120
C	Height of wheel-shaft from circular curbing on which wheel rests.....	34	36	40	44	48	54	60	65	70	75	80	85
D	Bore of upper half of wheel-shaft coupling.....	2½	3½	4	4	4½	4½	5½	5½	6½	6½	7½	7½
F	Diameter of hole in floor of Penstock for cylinder of wheel.....	25½	29½	33½	38½	44½	50½	57½	63½	72½	79½	86½	95
G	Distance from center of gate stem to center of wheel shaft.....	12½	14½	16½	18½	20½	23½	26	30	33	37	40	44½
J	Height of Gate stem above circular curbing on which wheel rests.....	23	24	25	29	32	34	41	44	46	48	52	57
K	Distance from surface of circular curbing where wheel rests to tail water..	11	12	13	15	16	18	21	22	24	25	25	28
L	Depth of water in pit when water discharges in front of Penstock.....	32	36	42	48	56	64	72	80	88	98	104	120
N	Depth of Water in pit discharging at front and one side.....	22	24	28	32	36	40	44	48	52	58	64	70
Q	Diameter of bore of upper half coupling of gate stem.....	1½	1½	1½	1½	1½	1½	1½	1½	2½	2½	2½	2½

This table can not always be followed arbitrarily, in two or three dimensions under low falls for large wheels; as it is often impossible to obtain the depth of the line BB. When this can not be done, the width B, should be increased, so that the depth and width multiplied together, will equal that in the table.

Large wheels under low heads often require heavy, circular curbing on the floor, to carry the wheel; that the lower side of penstock sills may be nearly level with the tail water, as the distances L and N are sometimes difficult to obtain. The depth of the penstock is thereby increased, affording the necessary length of draft tube. When several wheels are placed in the same penstock, some of these dimensions should be changed.

The measurements for the inflowing water, the size of penstock, and the outflow at the pit, are estimated upon a loss of 3 to 4 per cent. of the head water. To prevent a part of the loss of head, estimated above, larger flume, penstock, and pit, should be adopted, to give a slower speed for the entrance and discharge of water, thereby reducing its velocity and friction, before and after acting upon the wheel.



GLOBE AND CYLINDRICAL CASE DIMENSIONS.

GLOBE and CYLINDER Case Dimensions.

N.B.—All measurements in this table are given in inches.

W—Diameter of James Leffel Water Wheels.

A—From face of inlet flange to center of wheel shaft.

B—Inside diameter of inlet pipe.

D—Inside diameter of draft tube.

H—From foundation of case to center of wheel couple.

K—From foundation where case rests to top of case.

L—Distance between centers of gate rod and wheel shaft.

M—Diameter of entire casing.

N—From foundation to face of draft tube flange.

P—From foundation of case to center of gate couple.

R—Bore of top half couple of water wheel shaft.

S—Bore of top half couple of gate rod.

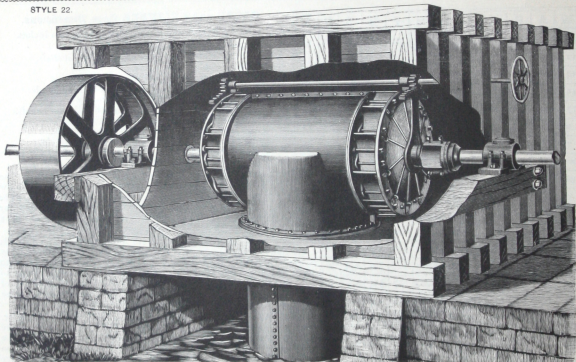
Pages 12 and 13 show and describe these cases. The **GLOBE** is made of cast iron and for all sizes of wheels below 23 inches diameter. They are intended usually for heads as high as 40 to 50 feet; but are made specially strong for higher heads. When made of unusual strength an extra price will be charged. (See pages 14 and 25.)

The **CYLINDRICAL CASES** are built with cast iron heads and wrought sides for all sizes of our wheels above 17½ inches diameter; and are adapted as ordinarily made, to heads as high as 10 to 20 feet. When greater heads are to be used, they are built stronger. We should be informed of the conditions, where unusual high heads are used, that these cases may be built in strength and weight to suit.

The cylindrical cases for wheels above 50 inches diameter, are built in halves for handling and shipping; they can be bolted or riveted together when setting the work in place. The cast iron flange shown on inlet at B C in the cut is placed upon all wheels below 40 inches diameter. Cases for wheels above

W	A	B	H	K	L	M	P	R	S	D	N
10	17	14½	33	13	6½	32	24	1½	¾	11	13
11½	20	18½	35	14	7¼	38	26	1½	¾	14	14
13¼	20	18½	35	14	8½	38	26	1¾	¾	15	14
15¼	21	21½	38	16	10½	43	28	1½	1	18	15
17½	24	23½	40	17	11¾	51	30	2	1	20	16
20	26	26½	42	19	13¾	54	32	2½	1½	23	18
23	28	30½	45	20	14¾	57	34	2½	1½	27	20
26½	36	42	72	54	17¼	60	66	2½	1¼	31	
30½	42	54	84	66	19¾	72	78	3½	1¾	35	
35	42	54	84	66	22¼	72	78	4¾	1¾	40	
40	48	66	96	78	25¼	84	90	4¾	1½	46	
44	48	66	96	78	27¾	84	90	4¾	1½	50	
48	57	78	111	90	31¾	102	105	5¾	1¾	53	
50	57	78	111	90	32½	102	105	5¾	1¾	56	
56	66	90	123	102	36	120	117	5¾	1¾		
61	66	90	123	102	37½	120	117	5¾	1¾		
66	78	102	138	114	40½	144	132	5¾	1¾		
74	78	102	138	114	46	144	132	6	1¾		
87	90	114	150	126	53¾	168	144	6½	1¾		

STYLE 22.



WOOD PENSTOCK TWIN COMBINATION WATER WHEEL.

Water in falling is actuated by the same law as other falling bodies; passing through 1 foot in $\frac{1}{4}$ of a second, 4 feet in $\frac{1}{2}$ second, 9 feet in $\frac{3}{4}$ of a second, and so on; hence its velocity flowing through an aperture in the side of a reservoir, bulkhead or any vessel, is the same as that of a heavy body falling freely from a height equal to the distance between the middle of the aperture or hole to the surface of water below.

New Standard Globe Mining Wheel. (Style 7.)

The opposite page shows our patent Globe Case Mining Wheel. This new style (7) is the simplest form of the type on horizontal shaft; it is our patent casing placed vertically, enclosing a Standard James Leffel Wheel. The water discharges in one direction parallel with the shaft, then turns downward through a curved pipe or draft-tube. All the bearings run in oil and none in water; thus saving power by reducing friction. The form of casing secures greatest strength with the least weight. The wheel and casing are built on strong steel "I" beams, and are easily taken apart if necessary. Style 7 is well adapted to Mining purposes; but is not confined to that use alone. It is often used in Saw Mills, Woolen Mills, and for driving any kind of machinery, where the power is taken from a horizontal shaft. Direct connection can be made, to a variety of machinery, by belting from one or more pulleys, on either or both sides of the water wheel shaft.

Horizontal shaft wheels have been made, to some extent for a number of years. Experimental wheels of this type, were made by us many years ago; our present work being far superior to any heretofore built. We have made important improvements in this wheel recently, especially the gate apparatus, securing greater ease in opening and closing the gates, by our patent balance thrust arrangement and other devices. A far better arrangement of the bearings has been adopted, and a new device employed, for relieving the step or pivot of the pressure, which affects Single Discharge Horizontal Wheels.

When ordering wheels on Horizontal Shafts, parties should state particularly which direction the pulley should run, whether upward or downward on the side next the observer, when standing in front of the inlet opening on the side. As the pulley can be placed on either side of the inlet, mention should be made on which side it must be placed. The inlet opening can be placed in any position from the side to the top of casing. Tables of power for these wheels are found on pages 15, 16 and 17 inclusive.

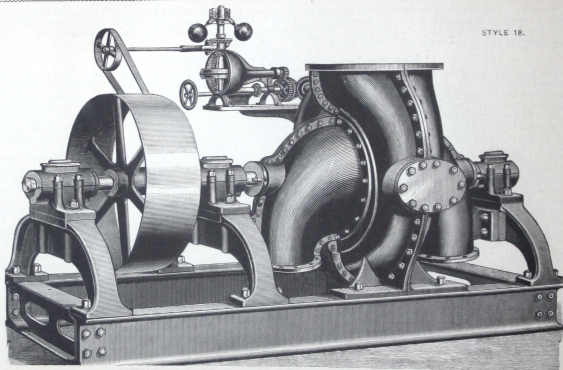
Ogden Milling Elevator Co., Ogden, Utah, says: "We are running our 200 barrel mill with one of your 44 inch standard wheels, under 16 foot head, and have power to spare. We consider your wheel the best we have ever used."

W. H. Earles, Milwaukee, Wis., says: "The wheel purchased of your company by the Kaukauna Electric Light Co., is giving satisfaction in every way. We are well pleased." (*Electric Light Plant.*)

J. W. Seely & Bro., Castle Dale, Utah. "We esteem it a privilege to express our satisfaction to the fullest extent in relation to your water wheels. We are using a 17 inch under 19 ft. head, and had it not been for that little giant of Leffel's turbine, we should not have been able to put up a mill as cheap and handy as we did." (*Flour Mill.*)

Toledo Mining Co., Sheridan, Montana. "Our 15 $\frac{1}{4}$ inch James Leffel Turbine Water Wheel gives the best satisfaction. We have a 50 ton concentrator, and the wheel works like a clock, giving power enough to run another 50 ton concentrator. We have had this wheel in use about a year, and it works as smooth as the first day we started." (*Concentrating Plant.*)

STYLE 18.



IMPROVED DOUBLE DISCHARGE JAMES LEFFEL WHEEL.

New Design Double Discharge Wheel.

Pages 38 and 40 illustrate the newest and most efficient designs of our NEW DOUBLE DISCHARGE James Leffel Wheel. The casings are flattened enclosing the Leffel Wheel modified from the ordinary Standard. The principal feature of these are their double discharge; the water being divided equally at the center, and passing parallel with the shaft in opposite directions, discharges downwards on each side of the wheel, through curved pipes. The casings are made narrow through the central portion, to obtain the shortest distance between the journals, bringing them as near to the wheel as the discharge space will admit; securing a solid arrangement in compact form. These wheels often connect direct from the pulleys on the wheel shafts to Saw Mills, Dynamos, Grinding Mills, Pulp Grinders, and various other kinds of mills. We often use pulleys on both sides of the wheel, and in some instances, two or more pulleys have been applied on the same side. These illustrations show the simplest plans, but are subject to other modifications, adapting them to unusual conditions, to which we have in many instances applied them with the highest degree of success.

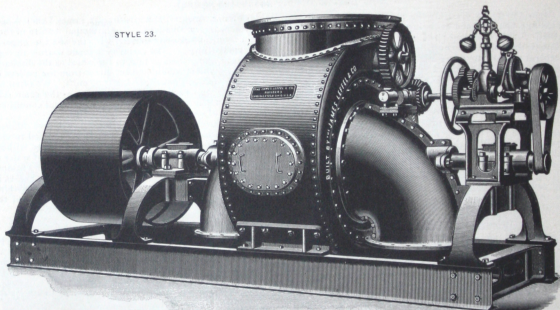
We make over FORTY different styles of this Wheel. These may however be comprised in essentially five different styles. Both pages, 38 and 40, show governor attachments, which are often necessary when wheels are applied to very irregular work. The governor, however, is an exception rather than a rule; as the wheels are frequently used without regulators of any kind. Occasionally air chambers are applied to this style of wheel, to reduce the concussion of water in the use of a governor, occasioned by sudden closing or opening of the gates. The chamber acts as an air cushion, receiving the shock, and relieving to some extent, the sudden unusual pressure that the long column of water causes in being suddenly checked in its flow or velocity. Opening and closing the gates should always be gradual, under anything more than ordinary heads, and especially where long pipes are leading to the water wheels. A sudden closing of the gates of any wheel incurs the liability of bursting the head-pipe, while a sudden opening may cause its collapse.

Chas. B. Wickham, M. E. & E. E., Anaconda, Mont., says: "I find that the three Turbines installed by your company for the Anaconda Elec. Ry., Light and Power Co., have been doing their work steady for the past two years, 24 hours a day, and every day in the year. The wheels have not had any repairs, or the casings opened for inspection during that time. They have given perfect satisfaction right from the start. With me, James Leffel Wheels first, all others follow." (*Elec. Railway & Power Co.*)

Electric Railway & Power Company. Wheels above mentioned are our Double Discharge like Style 18, opposite page, 23 inches diameter, under 120 ft. head, rated 900 H. P., 700 rev. per minute. (*James Leffel & Co.*)

A. N. Lombard, North Lincoln, Maine, says: "The Samson Wheel reached me in due time, and I have been driving my mill with it for the last three days. I felt pretty blue after I bought the wheel of you, to think I did not get along well with the wheel I had, but after starting your 35-inch Samson, it is driving my mill with so much power, it drove the blues all out of me in less than thirty minutes." (*Saw Mill.*)

STYLE 23.



30-INCH WHEEL.
550 H. P.

NEW DESIGN DOUBLE DISCHARGE JAMES LEFFEL WATER WHEEL.

Fine Design Double Discharge. (*Opposite page.*)

The foregoing page shows another style of our new type of wheel on horizontal shaft. While in principle and operation it does not differ essentially from styles 18 and 28, pages 38 and 44, it is quite different in construction. It shows also our new method of operating the gates, by means of one of the most approved styles of governor; it is observed that a worm gear is used in connection with the gate operating mechanism, securing thereby a firm, steady and easy gate opening apparatus. A fuller description of this general class of wheels may be found in the article on page 39 of this pamphlet; although in each of the styles the inside part of the gate arrangement and the governing devices are different, but the general internal arrangement is essentially the same in the three different styles.

Our firm recently built and put into operation several of these wheels, among which might be incidentally mentioned three of 30½ inches diameter, the powers of each being respectively 275, 400 and 550 horse; the first one of which is driving a flouring mill, the second an extensive electric light plant, and the third a large electric power plant; each of the last two companies using about 1,200 horse power of our wheels.

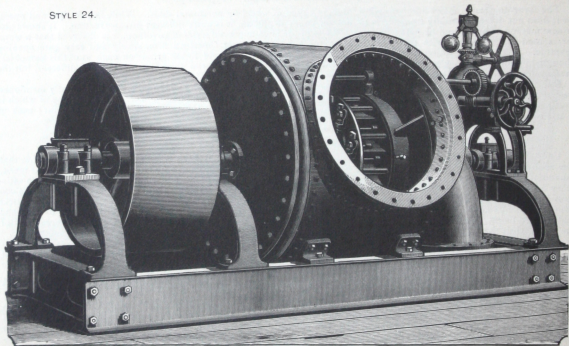
Over 14,000 James Leffel Wheels in Use, Giving Over 600,000 Horse Power.

Undoubted evidence of the excellence and superiority of the James Leffel Wheel, is found in the immense number that have been put in operation under an endless variety of circumstances. There can be no stronger proof of its great merit, to manufacturers who depend upon water power, than the fact of the large number that have been put in use. So satisfactory have been their performance, that the James Leffel & Co., have put into successful operation not less than 14,000 James Leffel Wheels, yielding the immense working capacity of not less than 600,000 horse power; there is no practical evidence so convincing to any unprejudiced person of the unequalled merits of our work. MANY HUNDREDS OF LETTERS could be produced, in addition to the few we have published from time to time, if that kind of evidence is regarded of more value, than the fact of the tremendous number at actual work.

A. E. Atherton, Atlas, Mich., says: "The Samson 20-inch Water Wheel I bought of you last July, is the best wheel on earth today. I can not say too much in its praise. When we first started the wheel, some four weeks ago, the water was some four feet below flume level, and I belted a four foot feed buhr to her, and it ground forty bushels an hour, with two-thirds gate, and drove it easy. I shall attach all my bolting machinery of my 50 bbl. mill and a buckwheat huller, and a buckwheat buhr for grinding buckwheat." (*Roller Mill.*)

J. Decker, Hanlon, Tenn., says: "The 35-inch Samson Wheel is thoroughly satisfactory. It displaced a 40-inch wheel of another make, and gives three times the power. We run our 35 bbl. mill with one-half gate, at 5 foot head, and with a 6 foot head we run both flour and corn mill with two-thirds gate. It required full gate of the other wheel to drive either mill. The Samson is efficient at any gateage. We can run steadily pulling the smutter alone, or all mills combined." (*Flour and Feed Mill.*)

STYLE 24.



NEW STEEL CYLINDER CASE SINGLE DISCHARGE WHEEL.

New Cylinder Case Single Discharge Wheel.

The opposite page shows a style of wheel, three of which were recently furnished the Ute & Ulay Mining Co. It is a modified form of the type on horizontal shaft, illustrated extensively throughout this pamphlet. This style is essentially the same in principle and operation, as style 7, page 36, but they differ materially in their appearance. This wheel is of the single discharge class, to which the water is admitted, either on the side, on the top, or at any angle between a vertical and horizontal line. It is regulated by our new arrangement for operating the gate, with one of the most approved governors, and can be quickly changed from a governor regulation, to a hand movement of the gates, by means of a hand wheel shown in the illustration.

A more general description of this style will be found in the article describing our "New Standard Globe Case Mining Wheel," page 37. These wheels are made in all sizes, from the smallest up to the largest, when required. Highly efficient in service; and thoroughly tested in practice.

Relative Cost of Power Transmissions.

The following comparisons were taken from a recent foreign paper, from which it appears that for long distances electricity leads in economy over the other systems. It has also an advantage in the greater ease with which the power may be subdivided, and distributed. Besides its utility as a transmitting medium it serves the general purpose also of illumination.

The method by Hydraulics is quite similar to that of compressed air, excepting that water was used instead of air, and the pipes through which it was forced were of larger capacity. A steam engine was used in each experiment as the prime mover.

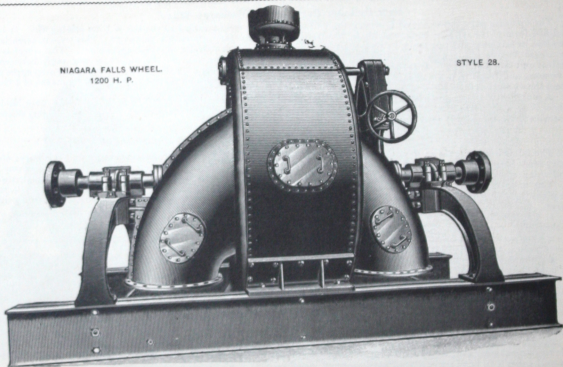
1. Comparative cost on 10 horse power transmitted 1,093 yards: By cables, 1.77 per effective horse power per hour; by electricity, 2.21; by hydraulics, 2.90; by compressed air, 2.98.
2. Comparative cost on 50 horse power transmitted 1,093 yards: By cables, 1.35 per effective horse power per hour; by hydraulics, 1.87; by electricity, 2.07; by compressed air, 2.29.
3. Comparative cost on 10 effective horse power transmitted 5,465 yards: By electricity, 2.64 per effective horse power per hour; by compressed air, 4.66; by cables, 4.69; by hydraulics, 5.29.
4. Comparative cost on 50 effective horse power transmitted 5,465 yards: By electricity, 2.37 per effective horse power per hour; by cables, 2.65; by compressed air, 2.99; by hydraulics, 3.02.

Myron D. Stevens, Golden, N. V., says: "I am running a saw mill that has one of your wheels which has been in constant use for nine years, and is in good repair. I can see no reason why it will not last a lifetime." (*Saw Mill.*)

J. B. Nichols, Glade Farm, W. Va., says: "I have one of your 15 1/4 inch wheels driving a pair of 42 inch buhrs and machinery under a 25 ft. head on half gate of water, giving good satisfaction. Also one 48 inch wheel driving saw mill under 5 ft. head doing good work." (*Flour Mill.*)

NIAGARA FALLS WHEEL.
1200 H. P.

STYLE 28.



DOUBLE DISCHARGE WATER WHEEL FOR NIAGARA FALLS, 1200 H. P.

Two World's Fair Diplomas and Two Medals.

The Columbian Exposition have awarded James Leffel & Co., Two Diplomas and Two Medals for their excellent work exhibited at Chicago. The Medals are the highest awards issued by the Exposition for Turbines.

Powerful Turbines for Niagara.

The opposite page shows the outward appearance of one of a plant of wheels, recently furnished the Cliff Paper Co., of Niagara Falls. It is our new style of James Leffel Double Discharge Wheel, admitting the water between the steel foundation beams below, discharging horizontally from the wheel on each side, and finally passing down on each side of the mouth piece or supply pipe. The Casing is built of steel plates, and cast iron heads, substantially secured by stay bolts. The shafting is of the best hammered scrap, and the runner, which is 67 inches in diameter, making 225 revolutions per minute, is made of bronze, except hub and arms, all however unusually heavy and strong. The gates are steel, and are operated by our new Patent Balance Thrust gate arrangement. The weight of the entire wheel as shown in the illustration, is 30 tons. They were sold under a guarantee of durability, and against breakage of any kind for a stated time, and to perform satisfactorily a specified amount of work in a given period.

Both these wheels are supplied, from one pipe of 8 feet diameter, leading from a canal at the top of the cliff to the wheel house, affording a head pressure of 130 feet. A large air chamber is placed on the top of casing, which is shown partly broken away in the cut. This chamber relieves any pounding or concussion, that might occur during sudden irregular supplies of water, to the wheel from the canal or head pipe. The wheels are rated at something over 1100 H. P. each, the two giving nearly 2400 Horse Power; making over 30 tons Dry Pulp per day. Each wheel is connected on each side directly to the large wood grinders, and the other machinery, without the use of gears, pulleys, or belts; affording the simplest and most effective Water Wheels, and the finest Power Plant that can possibly be adapted.

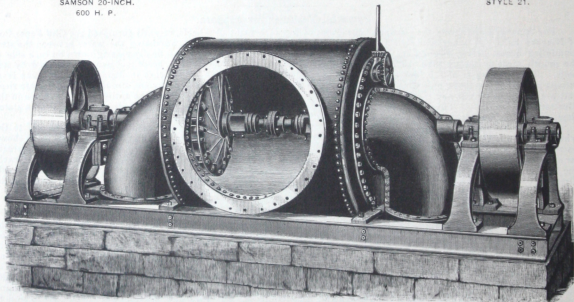
1700 Horse Power; Transmission 17 Miles.

A plant of three pairs of our Samson 20 inch Wheels, with Horizontal Shafts, is now in successful operation, at the Falls of Juanacatlan, Mexico. They are represented by the illustration on page 46 (Style 21), except that the pulleys on the Samsons have 16 grooves each, for hemp rope transmission. The Wheels of the Plant are also supplied, each with Governors not shown in cut, affording a nice regulation. Each wheel is nominally rated 600 Horse Power, transmitting electrically some 1000 to 1100 H. P. to Guadalajara, a distance of 17 miles. Two pairs of these wheels were first ordered, and put into practical service. The performance of these was found so satisfactory that a third pair was ordered, to fully complete the plant, and afford a reserve power. The runners are made of best bronze, shafts hammered, and gates and smaller parts steel; affording a design and make of wheel without an equal, in durability, in ease of operation, and in general performance. These Wheels operate under a head of 60 feet. They are used for lighting and power purposes.

When ordering *don't fail* to state whether face of pulley next to observer must run UP or DOWN.

SAMSON 20-INCH.
600 H. P.

STYLE 21.



NEW TWIN DOUBLE DISCHARGE JAMES LEFFEL WHEEL.

New Twin Double Discharge. (Style 21.)

The preceding page shows our new Twin Double discharge Wheel, like Style 19, page 49, comprising a steel cylindrical casing, with heavy castiron heads, also two regularly built, **Standard, Special** or **Samson** James Leffel Wheels, discharging in opposite directions from each other and passing down from each wheel in separate elbows ending in draft-tubes. As to discharge of water, this form is similar to Styles 18 and 23, pages 38 and 40. Like all other forms of horizontal shaft wheels of our make, the inlet opening can be placed at any angle from a horizontal to a perpendicular, or any position from the side to the top. Page 46 shows two pulleys, one on each side of the wheel. Like the other forms, more than one pulley, several in fact, may be placed on either end of the shaft, a number of such plants of our work being in daily operation. When ordering don't fail to let us know whether face of pulley next observer must run up or down.

Percentage Tests of Water Wheels.

The usual method of obtaining the percentage of useful effect, from a given quantity of water, is by a friction brake, or by raising weights. The quantity of water, and the amount of head and fall being carefully compared with the amount of resistance overcome. Such tests, in a measure, give comparatively reliable theoretical results, in the hands of competent and honest parties, but they do not afford reliable evidence of the useful effect of a wheel, subject to unfavorable circumstances of location, and constantly changing speeds under varying conditions. We have held this view of the matter since the publication of an article on that subject, in our water wheel pamphlet issued in 1867, and we have no occasion to change our minds after all these years of practice. In a percentage test, the wheel is tried for a few seconds, at a perfectly uniform speed, discharging the same quantity of water for each interval of time, with the flume and pit in the very best possible condition, for receiving and discharging the water. The gateage is then perhaps changed several times, and a few seconds test made in each instance, under the same uniform conditions as before. Yet wheels rarely ever repeat the results, when tested at some other time, at the same place, although there may be no perceptible difference in any of the details of the experiments or trials on the two occasions.

Wheels in every day practice, are in a majority of cases, running under unfavorable circumstances; not only as to the entrance and discharge of water, but as to the size and proportion of gears, and the location of wheel in relation to the work. The speed of machinery in most plants, such as electric light, electric power, rolling-mills, mining machinery, saw-mills, etc., is always changing and exceedingly unsteady. These changes are never uniform, always effecting the speed of the wheel, making it irregular and of course necessarily different quantities of water are discharged, during each interval of time, which is not the case with the uniformly favorable conditions of the testing flume. No percentage tests, however carefully and honestly conducted, will afford a truthful indication of the real power obtained; under the unfavorable conditions just mentioned, to which wheels at actual labor are always more or less subject. Many wheels apparently obtaining high percentage at full gateage, in testing flumes fall very rapidly in usual effect, on irregular gate openings under unequal demands of power. As a consequence some wheels of high percentage record, will fall far below more ordinary wheels in

their average work, when submitted to the ever varying changes in practical use. An expert water wheel man who claims large experience in improving turbines, recently said, after 18 years of incessant labor and experimenting, he finds it impossible to produce wheels, which will yield as high results, as some other builders advertise for wheels that he himself perfected for them. The same party, after having given the names of several manufacturers, who are constantly publishing tables of high percentage, further states that it is remarkable that manufacturers of Turbines should use such presumption towards owners and users of water powers; and he offers a wager that the same parties can not reproduce the results of tests such as they publish, with wheels made and sold to the trade from the same patterns of the wheels that they claim to have tested. Tests of *eleven* wheels built by one of these parties, average only 41 per cent. of useful effect, when running at half gate, or with half the water used at full gate. Users of wheels never hear anything of these results, as only whole gate percentages are advertised.

The difficulty of obtaining percentage tests, that are known to be honestly and reliably made, and that indicate the actual comparative merits of competing wheels, leads us to the unavoidable conclusion, that the only reliable method of ascertaining the real worth of the wheel, in the various points of economy of water, steadiness of motion, part gate qualifications, strength and durability, its ease of management, and expense and convenience of repair, can only be demonstrated fully, by its actual use in driving machinery, for a length of time sufficient to prove its merit in those respects.

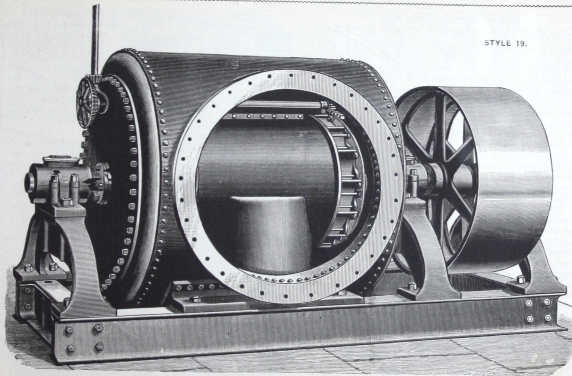
Twin Combination Single Central Discharge. (Style 19.)

The next page shows our new twin combination. This style consists of two regular James Leffel Wheels, either **Standard, Special** or **Samson** placed in a large, heavy and substantially built cylindrical steel plate casing, with strong cast iron heads. Both wheels discharge the water horizontally towards each other, uniting and passing downward through one large capacity *central discharge* pipe. Any ordinary length of draft-tube can be attached to this pipe, enabling the wheel to be placed at any height above the tail water. The inlet opening can be placed at any angle, from a horizontal to a perpendicular, admitting the water directly on top, or on the side, or at any point between the top and side. One pulley is shown, but two or more can be placed on the same shaft, and at each end if most convenient; requiring only an extension of the shaft, and an increased number of bearings. Other modifications of this wheel, with governor attachments, etc., are frequently made. The tables of powers for these wheels are found on pages 15 to 23 inclusive, merely by taking twice the power of one wheel, there being two in the combination.

T. B. Scott Lumber Co., Merrill, Wis., state: "We have in use in our mill 6 of your turbine wheels, sizes from 44 to 87 inches, running under an 8 ft. head, and which operate to our entire satisfaction."

Calgary Water Power Co., Ltd., Calgary: "The two 50-inch Samson Water Wheels, and other machinery you shipped us a year ago, have given entire satisfaction. We have tested the Wheels, and find that we can get more power from them than you guaranteed."

STYLE 19.



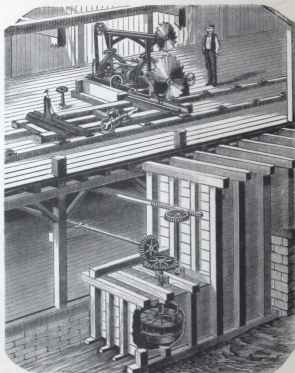
NEW TWIN COMBINATION SINGLE DISCHARGE WHEEL.

Heavy Circular Saw Mill.

This shows a first class Mill, of modern style, capable of cutting a large amount of lumber. The minor details are omitted, that the Circular Mill, penstock, Water Wheel and the general plan may be easily understood. The Water Wheel may be our 35 or 40 inch, under a 12 to a 16 feet head, placed in a decked penstock, built in the manner of that shown herewith and on pages 60, 64 and 71. The lower the head the less resistance required in posts and planking; but nearly the same aggregate strength in the floor and sills is required, since a larger floor and more space go with larger wheels, which are used under the lower heads. It is not necessary that the decked penstock in all cases be used for Saw Mills; it usually happens where the head is more than an average height, as a convenience for taking off the power below the level of head water.

When the head water and penstock are low and the floor of Mill high, the open penstock may be adopted, similar to that on page 65, in which there is no decking or offset; the wheel simply being set over a hole, cut in the floor of the penstock, with wheel cylinder extending through the hole, touching the tail water. The wheel shaft should extend above the cap timbers, upon which a gear is placed, for working into one on a horizontal shaft; conducting the power under the main floor, where it can be taken by pulleys and belts, through the floor. The driving pulley on line shaft and the belt, are not shown on this page; being under the floor, the belt passes through the floor to the pulley on Saw Mandrel, out of the way of the workmen and lumber. The gate apparatus beyond the log carriage, can be located at any convenient place, and may be attached by a rack connection, to the gate rod pinion at the Water Wheel.

300 Leffel Wheels are driving Saw Mills of all styles and capacities, in every part of the country.



BORE OF PIPES IN INCHES.

FALL PER MILE IN FT.	Fall per rod in In.	8	10	12	14	16	18	20	22	24	27	30	33	36	40
2.64	.10						2.79	3.37	4.53	5.59	8.27	10.3	12.9	16.4	22.1
3.70	.14						2.25	3.10	4.07	5.25	6.64	9.09	11.9	15.2	19.8
4.75	.18				1.83	2.59	3.49	4.68	6.01	7.56	10.3	13.5	17.6	22.3	29.8
5.28	.20			1.26	1.91	2.72	3.66	4.92	6.32	7.95	10.8	14.2	18.8	23.5	31.5
6.33	.24		.87	1.40	2.11	3.02	4.06	5.40	6.94	8.75	11.9	15.8	20.3	26.1	34.7
7.39	.28	.53	.96	1.48	2.27	3.28	4.40	5.82	7.51	9.47	13.0	17.2	22.2	28.3	37.6
8.44	.31	.57	1.04	1.63	2.44	3.49	4.75	6.27	8.05	10.1	14.0	18.6	23.8	30.3	40.6
9.50	.35	.61	1.11	1.72	2.59	3.69	5.03	6.65	8.55	10.8	14.8	19.7	25.2	32.5	43.1
10.56	.39	.63	1.19	1.82	2.72	3.92	5.30	7.05	9.07	11.4	15.6	20.8	27.0	35.2	45.2
11.62	.43	.66	1.26	1.94	2.88	4.12	5.63	7.42	9.55	12.1	16.5	21.8	28.3	37.8	48.1
12.67	.47	.70	1.32	2.02	3.02	4.32	5.87	7.79	10.0	12.6	17.2	22.9	29.0	39.4	50.5
13.72	.51	.73	1.37	2.11	3.15	4.51	6.18	8.14	10.5	13.2	18.0	23.9	31.1	40.9	52.7
14.78	.55	.76	1.42	2.20	3.29	4.68	6.38	8.48	10.9	13.8	18.8	24.9	32.3	43.3	55.1
15.84	.59	.82	1.47	2.29	3.42	4.87	6.64	8.77	11.3	14.3	19.5	26.9	33.6	46.0	59.3
16.88	.63	.87	1.58	2.46	3.62	5.31	7.17	9.49	12.3	15.5	21.1	28.0	36.2	48.9	61.1
17.93	.67	.93	1.68	2.66	3.99	5.67	7.65	10.2	13.1	16.6	22.6	29.9	38.6	55.0	65.4
18.99	.71	1.04	1.86	3.02	4.46	6.39	8.66	11.4	14.8	18.7	25.4	33.6	43.1	60.0	73.1
19.68	.75	1.15	2.05	3.31	4.91	7.02	9.54	12.6	16.2	20.4	27.8	36.8	47.4	65.2	80.3
20.76	.79	1.26	2.22	3.60	5.37	7.66	10.3	13.7	17.5	22.1	30.0	39.7	51.4	69.8	86.7
21.84	.83	1.34	2.38	3.85	5.77	8.16	11.1	14.7	18.8	23.6	32.0	42.4	54.9	74.3	92.6
22.92	.87	1.42	2.51	4.07	6.11	8.64	11.7	15.6	19.9	25.1	34.0	45.2	58.2	78.5	98.0
24.00	.91	1.49	2.66	4.30	6.44	9.10	12.4	16.5	21.1	26.4	36.9	47.7	61.6	82.9	
25.08	.95	1.56	2.83	4.57	6.81	9.55	13.7	18.0	23.1	29.0	39.8	52.9	67.0		
26.16	.99	1.64	2.93	4.72	7.00	9.95	13.7	18.0	23.1	29.0	39.8	52.9	67.0		
27.24	1.03	1.72	3.11	5.09	7.60	10.9	14.8	19.5	24.7	31.5	43.2	57.7			
28.32	1.07	1.81	3.25	5.48	8.17	11.6	15.9	21.0	27.0	33.9	46.6				
29.40	1.11	1.91	3.47	5.83	8.93	12.4	16.9	22.5	29.7	36.2	48.1				
30.48	1.15	2.03	3.65	6.16	9.26	13.2	17.9	23.6	31.2	38.5					

Flow of Water, Through Clean Pipes.

This table has been specially arranged by us from formula and parts of tables by Randall; and gives the quantity of water in cubic feet discharged per second, flowing through smooth iron pipes, the length of each is estimated at one thousand times the diameter. The length of the pipe affords a resistance to the flow, according to the quantity of water passing, or the velocity with which it is discharging. Any length of pipe in this table of less or more than one thousand diameters, will have an additional increase or decrease of flow, which may be estimated from our table on page 54.

This table is given for clean, smooth piping. When ordinarily rough the flow will be about twelve per cent. less than the quantity given. If very rough, a loss of nearly twenty-five per cent. would have to be deducted from the estimate in table. If bends or angles are introduced, these will materially effect the discharge also, depending on the number and the abruptness of the bends. Bends should be of the longest possible radius, and all contracted portions of the pipe should be avoided. It would be difficult to give any formula, or general rule to answer all the cases that might occur in connection with these angles or bends, which may frequently arise from undulations in the profile of the pipe, or by horizontal deviations from straight lines. The first horizontal line in heavy figures represents the different sizes of pipe in inches; and the first vertical column represents the fall per mile in feet and hundredths of a foot; the second upright column the fall in decimals of an inch per rod. All the perpendicular columns following the two already described, show the number of cubic feet discharged by each pipe, under each head in cubic feet and hundredths of a cubic foot per second.

3000 Complimentary Letters; We have fully this number of testimonials on file at our office.

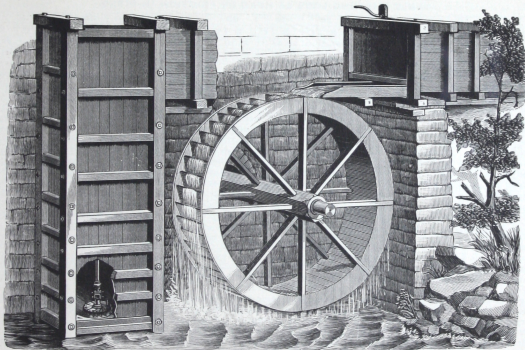
Overshot and Turbine Compared.

Page 53 shows some of the reasons why an overshot, even of the best construction, will not yield the full power of the water. We show how our wheel will produce an increased power, by reason of being free from those objections in an overshot, which largely diminish its efficiency by a waste of water and loss of a part of the fall. We have selected a head and fall of eighteen feet, being the most common fall for overshots. It is usual to allow a head of water of about two feet, above the overshot, and to prevent the dragging of the wheel in tail-water, a clearance of at least six inches allowed; the wheel therefore for this fall can not exceed fifteen feet six inches diameter. It is common to regard the entire head of water above the overshot wholly lost; but we will concede the benefit of one-half of the head. There will then remain to be deducted from the whole fall—1st, one foot above the wheel; 2nd, one foot for depth of rim, below which will be a line where the buckets are entirely empty; 3rd, six inches clearance below the wheel; which makes together a loss of two feet six inches fall; and as the water begins to empty from the buckets at some distance above the water in the tail-race, which is often nearly on a level with the shaft, particularly when the buckets are well-filled, it will be safe to say that the waste of water from this source will be equal to the loss of another foot of fall, which added to the amount of fall lost in the manner above described, makes a total loss of three feet six inches out of eighteen feet, or nearly twenty per cent. of the whole fall.

Our wheel is placed at the bottom of the penstock, touching the tail-water; thus utilizing every inch of the fall below the overshot. A line drawn through the top of the penstock, at the height of the head water in the forebay, would show that there is no loss at the head surface; as the water should stand at almost a perfect level, providing the forebay leading to the penstock is of sufficient capacity. There are a number of instances in which the Leffel has been supplied, where the height of the head-water was so great, and the surroundings so difficult, that the overshot could not be used in any form or manner. In fact, there is a limit as to the diameter of the overshot, beyond which they become impracticable; this circumstance only adding to the utility of our wheel, its excellence becomes more apparent with increase of head.

Shipping Facilities and Instructions. Several trunk railway lines, run on either side of our shop. These connect with all the trunk, and branch lines running through our city, enabling us to deliver aboard the cars free of drayage. Purchasers should remember that often the drayage, cartage and delivery to depots, are a considerable item of expense; while they are not often mentioned by manufacturers, such expense charges will often be found in bills rendered to the customer. We don't make any such charges. We have direct lines east, west, north, south, either to the Atlantic, Pacific, the Lakes or the Gulf; and can contract by this large railroad competition, the lowest possible rates of freight to our customers. Always give us some instructions, as to what route the machinery is to be shipped, in reaching its destination. We understand the best routes leaving our city; but in transferring to other roads, that sometimes occur near the destination, the customer may have some preference, as to what road should have charge of the shipment on its arrival.

A. B. Fisher, Caribou, Maine, says: "We have been running the New Leffel Samson, 56 inches diameter, about three weeks and it runs both the Electric Light Plants at half gate, and we are all much pleased with it."



OVERSHOT AND TURBINE COMPARED.

TABLE SHOWING LOSS OF HEAD BY FRICTION IN PIPES.

8	10			12			14			16			18			20			22			24			26			28			30						
A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C					
2	41.76	.25	65.40	.20	94.20	.16	128.16	.14	167.36	.12	212.00	.11	261.74	.10	316.72	.09	376.88	.08	442.26	.08	513.12	.07	588.88	.07	663.39	.16	769.68	.15	883.32	.14	1006.24	.13	1137.76	.12	1278.24	.11	1427.28
3	62.64	.51	98.15	.41	141.30	.34	192.24	.29	251.04	.26	318.00	.23	392.61	.20	475.08	.19	565.32	.17	663.39	.16	769.68	.15	883.32	.14	1006.24	.13	1137.76	.12	1278.24	.11	1427.28	.10	1585.68	.09	1752.48	.08	1928.16
4	83.52	.86	130.85	.69	188.40	.57	256.32	.49	334.72	.43	424.00	.38	523.48	.34	633.44	.31	753.76	.29	884.52	.26	1026.24	.25	1177.76	.23	1339.68	.22	1502.40	.20	1676.16	.19	1850.40	.17	2035.68	.16	2222.08	.15	2419.20
5	104.40	1.28	163.50	1.03	235.40	.86	320.40	.74	418.40	.64	530.00	.57	654.35	.52	791.80	.47	942.20	.43	1105.65	.39	1282.80	.37	1472.20	.34	1674.24	.33	1886.88	.31	2110.56	.29	2345.76	.28	2592.00	.26	2849.28	.25	3117.12
6	125.28	1.79	196.20	1.43	282.50	1.20	384.48	1.03	502.08	.90	636.00	.80	785.22	.72	950.16	.65	1130.64	.60	1326.78	.55	1539.36	.52	1768.64	.48	2015.04	.47	2278.56	.44	2559.36	.43	2848.32	.41	3145.44	.40	3450.72	.38	3764.16
7	146.16	2.39	228.90	1.90	339.60	1.59	448.57	1.36	585.76	1.19	742.00	1.06	916.09	.95	1108.52	.87	1319.08	.80	1547.91	.73	1795.92	.68	2061.08	.64	2344.32	.62	2645.76	.60	2965.20	.58	3302.72	.56	3657.28	.54	4029.92	.52	4419.60
8	167.04	3.06	261.60	2.45	376.70	2.04	512.66	1.75	669.45	1.53	848.00	1.36	1046.96	1.23	1266.88	1.12	1507.52	1.02	1769.04	.94	2052.48	.88	2355.52	.82	2677.28	.80	3017.76	.78	3387.04	.76	3785.12	.74	4211.84	.72	4667.20	.70	5151.36
9	187.92	3.79	294.29	3.03	423.80	2.53	576.75	2.17	753.14	1.89	954.00	1.68	1177.83	1.51	1425.24	1.38	1695.96	1.27	1990.17	1.17	2309.04	1.08	2649.96	1.01	3012.96	.99	3390.24	.97	3791.76	.95	4217.44	.93	4668.24	.91	5144.16	.89	5645.28
10	208.80	4.62	327.00	3.70	470.90	3.08	640.84	2.64	836.83	2.31	1060.00	2.06	1308.70	1.85	1583.60	1.68	1884.40	1.54	2211.30	1.42	2565.60	1.32	2944.40	1.23	3347.60	1.14	3762.80	1.06	4203.12	1.00	4668.00	.94	5157.28	.89	5680.64	.84	6232.32
11	229.68	5.52	359.70	4.41	518.00	3.68	704.93	3.15	920.52	2.76	1166.00	2.45	1439.57	2.21	1741.96	2.01	2072.84	1.84	2432.43	1.69	2822.16	1.57	3238.84	1.47	3682.56	1.38	4157.28	1.30	4651.20	1.23	5169.36	1.17	5715.60	1.11	6291.12	1.06	6886.56
12	250.56	6.49	392.39	5.19	565.10	4.32	769.02	3.71	1004.21	3.24	1272.00	2.89	1570.44	2.59	1900.32	2.36	2261.28	2.16	2653.56	2.00	3078.72	1.86	3533.28	1.73	4027.36	1.64	4550.40	1.56	5095.92	1.49	5699.92	1.42	6332.40	1.36	6994.40	1.30	7678.88
13	271.44	7.54	425.09	6.03	612.20	5.03	833.10	4.30	1087.90	3.77	1378.00	3.35	1701.31	3.02	2058.68	2.74	2449.72	2.52	2874.69	2.32	3335.28	2.15	3827.20	2.01	4347.36	1.90	4899.60	1.81	5491.92	1.73	6125.28	1.66	6786.72	1.60	7471.20	1.54	8185.60
14	292.32	8.67	457.79	6.93	659.30	5.78	897.18	4.95	1171.59	4.33	1484.00	3.86	1832.18	3.47	2217.04	3.15	2638.16	2.89	3095.82	2.67	3591.84	2.48	4122.16	2.31	4697.28	2.14	5297.76	2.00	5923.20	1.88	6598.72	1.78	7285.20	1.70	7968.64	1.63	8683.04
15	313.20	9.87	490.49	7.90	706.35	6.58	961.27	5.64	1255.28	4.93	1590.00	4.38	1963.05	3.95	2375.40	3.59	2826.60	3.29	3316.95	3.04	3848.40	2.82	4416.60	2.63	5020.40	2.45	5642.88	2.30	6320.16	2.17	7002.24	2.07	7727.36	1.96	8516.16	1.87	9319.68
16	334.08	11.15	523.18	8.92	753.45	7.43	1025.36	6.37	1338.96	5.58	1696.00	4.96	2093.92	4.46	2533.76	4.06	3015.04	3.72	3538.08	3.43	4104.96	3.19	4711.04	2.97	5349.12	2.78	6015.36	2.61	6709.92	2.46	7445.44	2.33	8127.36	2.22	8915.36	2.12	9719.04
17	354.96	12.50	555.88	10.00	800.50	8.33	1089.45	7.15	1422.64	6.25	1802.00	5.55	2224.79	5.00	2692.12	4.55	3203.48	4.17	3759.21	3.85	4361.52	3.58	5005.48	3.33	5729.76	3.14	6439.20	2.97	7175.36	2.82	7969.44	2.70	8793.60	2.59	9699.84	2.49	10619.28
18	375.84	13.93	588.58	11.14	847.60	9.29	1153.54	7.96	1506.32	6.97	1908.00	6.19	2355.66	5.57	2850.48	5.07	3391.92	4.65	3980.34	4.29	4618.08	3.98	5399.92	3.72	6209.76	3.50	7009.20	3.31	7898.88	3.14	8877.12	2.99	9923.52	2.87	11012.80	2.77	12188.96

Size of Pipe in Inches. A, Velocity Through Pipes in ft. per Second. B, Discharge per Minute in Cubic Feet. C, No. feet Loss of Head by Friction.

This table is taken from "Leffel's Construction of Mill Dams and Bookwalter's Millwright and Mechanic," published by James Leffel & Co. It has been modified, condensed and reduced somewhat, adapting it to this edition of pamphlet. The calculations have been accurately made from formulae of Weisbach; and will be found useful in determining the available power of water, moving at any velocity from one to 18 feet per second, through pipes from 8 to 30 inches inside diameter. The length of pipe for which the table is calculated is 100 feet. The loss of head by friction, varies directly as the length of the pipe, therefore the loss in a pipe of greater or less length than 100 feet, can easily be ascertained.

The first horizontal line of figures from 8 to 30 inches, indicates the size of the inside diameter of the pipes. The first perpendicular column A, with figures from 2 to 18, represents the velocity in feet per second of the water flowing through the pipes. The second perpendicular column B, shows the number of cubic feet of water discharged per minute. The third perpendicular column C, indicates the feet and parts of feet loss of head due to friction in each 100 feet length of pipe. These notations are given in condensed form below the table.

For example: to find the loss of head in a pipe 47 feet long, 10 inches in diameter, discharging 130.85 cubic feet of

water per minute. This rate of discharge will be found in column B, third horizontal line of figures indicates a velocity of 4 feet per second, see column A on same horizontal line. The loss of head is found in the column C for this 10 inch pipe, and a 4 foot velocity, viz., 69 one-hundredths of a foot for a hundred feet of pipe. A pipe 47 feet long will be 47 hundredths of this, which is equal to 32 hundredths of one foot loss of head.

Artesian Well Water Powers.

Frequently inquiries are made, concerning the amount of power that can be obtained from artesian wells. The idea generally prevails, that they should supply considerable power, inasmuch as there is always apparently a large quantity of water flowing from each well. This idea of power arises from the fact, that a high pressure is always obtained when the pipe is capped over or closed, and the water is supposed to flow under that pressure, when discharging from the open well at the surface. Our long experience however in the wheel business, and the many instances brought to our attention, have presented very few practical and successful powers from this source. Very small powers are quite often obtained from wells properly connected with motors, but large powers are exceedingly rare.

It is usually forgotten, or not generally understood, that the flow occurs nearly always under a very low pressure; and that a high pressure on the other hand, is obtained when the flow is very light and small. Either of these conditions being unfavorable, to the development of sufficient power for large or profitable concerns. The well tubing is so small, and often so deep, that the necessary conditions of quantity and pressure rarely happen together. Occasionally a well is located on an eminence or hillside, where a reservoir can be secured. Such a circumstance admits of the use of a larger wheel, by running part of the time, than could be used if the flow was taken direct from the well constantly.

That a party may obtain approximately, the amount of power a well affords, a measurement of the pressure ought to be obtained, at or near the surface of the ground, while the discharge is taking place. Greater accuracy would be secured in estimating the power, if a hole or nozzle of $1\frac{1}{2}$ or 2 inches was discharging from the well at the time the pressure was measured or taken. A record of the size and shape of the hole, and the pressure should be made, and from this data, the power estimated. A measurement of the exact height at which the water would spout, taken with the size of the nozzle, would also admit of estimating the power with considerable accuracy. We will be glad at any time to answer fully any inquiries on the subject.

Geo. A. Pierce, Mgr. City Mills Co., Columbus, Ga., says: "After thinking and weighing the matter carefully, I finally bought your Wheels. I am more than satisfied with them. They are today doing work that would surprise you. (Three large Samson Wheels.—J. L. & Co.)

F. Paustian, Maysville, Wis., says: "The Samson 40-inch Water Wheel has now been running two months, and I am not sorry I took your advice to take a Samson wheel, as it is very effective in opening and closing the gates, keeping a very even motion. Have never had a better wheel to drive the mill." (*Flour Mill.*)

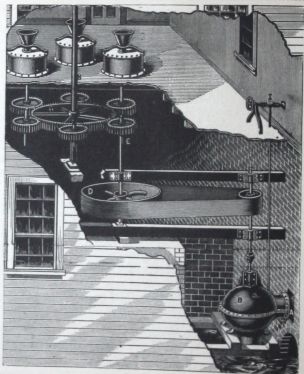
3000 letters on file in our office, praising the performance of our wheels.

Williams' Mill and Leffel Wheel.

Although this wheel is doing an astonishing amount of work, the machinery which it drives is not arranged in as simple a manner, as the peculiar advantages of our wheel would admit; the mill having formerly been run by two large overshot wheels. No essential change was made in any of the heavy pit gearing; but the wheel drives the heavy, and bulky machinery of the overshots; which, added to the work of propelling 5 pairs of large buhrs, makes its performance wonderful. This method can be adopted in connecting our wheel to the same machinery run by the overshot, where it can not be changed; but it is not the best plan. Head 96 ft., $15\frac{1}{4}$ wheel of $11\frac{1}{2}$ capacity.

The buhrs are attached to the spur wheel G; shaft H extends into the mill for running, cleaning and elevating machinery; the pinion E, which receives the power of the wheel through the pulley D, works into the spur wheel G, thereby driving any number of the buhrs at once. The belt from pulley on the water wheel shaft is 16 inches wide, and has a speed of almost 80 feet per second. The wheel is in the globe case, though the pressure in this case is over 43 pounds per square inch, it is perfectly water-tight, and shows no sign of strain. A screw and worm wheel is used for operating the gates, thus avoiding any sudden shock by suddenly opening or closing the gates. The casing B is bolted to timbers in heavy masonry. Sometimes it may be found convenient to use a short draft tube, the end of which should dip slightly into the standing tail-water. We always avoid the use of draft tubes when possible; when used they should be airtight.

Over **500 Overshots** have been displaced from time to time with our James Leffel Wheel. It is superior in a number of particulars.

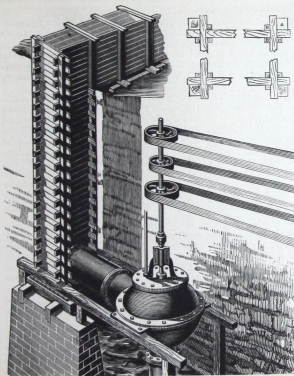


Wooden Penstock for High Falls.

This plan is for heads from 20 to 60 feet. If well built, it will stand even greater heads. The corner posts A (as shown in plan) need not be over 6 inches square. A 40 feet head with a penstock of the proper inside area to pass water for our 26½ inch wheel, giving 110 horse power, would require a penstock of 40 inches square inside, with a frame made to bolt the flange of the inlet pipe to the globe. The plank for first 15 feet should be 4 or 4½ inches thick; for 15 feet further, 3 inch plank for the rest 2 inch plank. The flume to pass the water into the top, should be the width of the up-right part of penstock, and 50 inches deep for a 26½ inch wheel, giving a cross section to the inflowing water of 14 sectional feet, passing the water nearly 2 feet per second. This slow velocity will not materially reduce the Head.

The plank should be gauged to a certain width. If the penstock is to be 40 inches square inside, cut one-half the number of planks 42 inches long. Size them down at each end to a thickness that they will all work. Take the same number of planks, cut them 60 inches long; if the plank is 4 inches thick this will allow them to extend to the outside of posts on each side. Then lay off evenly, 40 inches between gains, and gauged 3 inches from the face or outside of plank, which leaves a rabbet 1 inch to receive the 42 inch pieces. After all the planks are prepared, the 6 inch corner posts can be set up, and putting up the plank commenced and carried up until the place is reached to splice the posts. Plank should be double-spiked as the work progresses. The small corner strips marked B B B, should be well fitted and nailed. If the work is well done the penstock need not leak a drop. This penstock with 40 feet of water, would have a pressure of 28,160 pounds of water, besides the weight of penstock; therefore put it upon a solid foundation.

We have **3000** letters on file praising our Wheel.



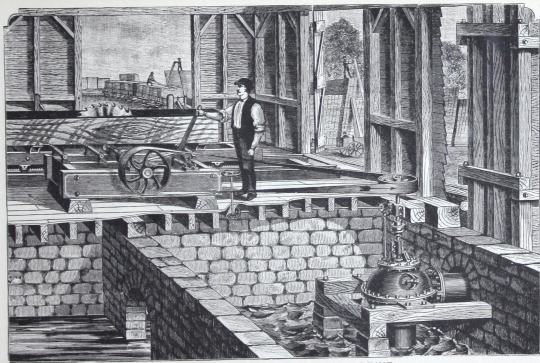
Circular Saw with Quarter-Turn Belt.

The following page gives a plan of a simple and efficient circular mill. This style with proper size and arrangement of pulleys, and suitable length of belt, cannot fail to give satisfaction. Mills of this plan, have wheels of comparatively small size, operating under heads of considerable height. The wheel is shown in our Patent Globe, with a head pipe attached, leading from the wooden penstock. The pipe attached to the bulkhead on outside of mill passes through the stone wall, and connects to the globe. To the sides of the globe casing are flanges to rest upon the sills, affording a convenient and solid support. A short draft tube is attached to lower part of cylinder, which is not necessary in all instances, as the wheel can frequently be placed at the bottom of head.

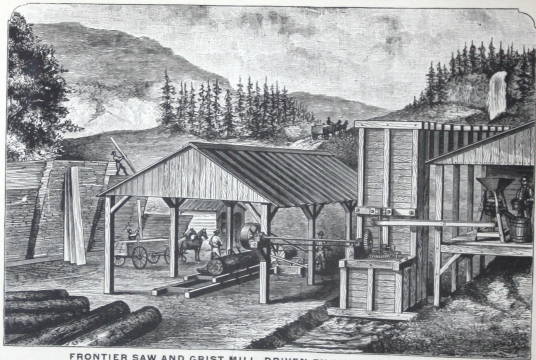
The power is transmitted to pulley on saw mandrel, by a quarter-turn belt, from a pulley on the water wheel shaft. One unacquainted with the arrangement of pulleys and belts in this manner, should obtain the services or advice of some one who has had some experience in arranging, applying and putting such belts into operation. The center of horizontal pulley on water wheel shaft in this instance, is placed nearly on a level with bottom of pulley on saw mandrel, and the center of pulley on mandrel is almost in a line with the lower edge of pulley on water wheel shaft, although it may not be seen in the illustration. The arrows indicate the only direction the belt can run, with this particular situation of pulleys in relation to each other. If the direction of belt is changed, then an entire change of the location of pulleys would become necessary. There need be no difficulty in the matter. When the method is adopted, it is best to have the pulleys some distance apart, perhaps 12 to 18 feet, and not too large in dimensions, nor should the one be very large and the other very small. When possible they should be as nearly the same size as the proper speeds of the water wheel and saw will admit. Almost always, however, the pulley on wheel shaft will be smallest, as the method is best applied to high heads and small wheels.

Gold and Silver Plated Water Wheel. The following is from the *Scientific American*: "We lately had the pleasure of inspecting a magnificent specimen of this motor, constructed by James Leffel & Company, of Springfield, Ohio, to order of the Smithsonian Institute, Washington, D. C. The wheel in question is very strong, having been built for a high head of water, its mechanical execution is perfect, and its finish resplendent. All the parts are highly polished, and heavily plated with gold and silver. This wheel is intended for the permanent museum of the institution, and was selected as the representative of standard excellence among American-made water wheels—a fact which is of course highly gratifying to the manufacturer, as well as thousands of manufacturers who use this effective and reliable machine. The Leffel is a double action wheel, being in fact two wheels combined on one shaft; is fitted with adjustable gates, and contains the latest improvements."

Andrew Gibson, Eng'r., Martin, Wash.—We use your new style double discharge 15¼ inch mining wheels, head 160 feet, to run an Edison 1,000 Volt Dynamo, to light Stampede Tunnel; this wheel is first-class in every particular, never getting out of order, and requiring very little water. We can conscientiously recommend this style of wheel where power and economy of water is essential. (*Electric Lighting.*)



QUARTER TWIST BELT, SAW MILL DRIVE



FRONTIER SAW AND GRIST MILL, DRIVEN BY JAMES LEFFEL WHEEL.

127,726 ft. Lumber per Day, Five Leffel Wheels.

James Leffel & Co., Springfield, Ohio:

GENTLEMEN—We use five of your turbine wheels, two 56, two 66 and one 40. We run three circulars, two lath mills, two edgers, nine trimmers, two large slab saws, two small slab saws, two log-jackers, two emery gummars, one edging grinder, and all the necessary carriers, etc. Our dam gives us an average head of about $8\frac{1}{2}$ feet. The average cut last season per day of 10 hours, including all stops from time mill started, April 15th, until shut down, November 12th, was 127,726 feet. We are well satisfied with the wheels, and for any ordinary head of water, think they are the best in the market.

Very truly yours,

PESHTIGO, WIS., April 25, 1890.

THE PESHTIGO COMPANY.

Frontier Mill, Grist and saw Mill.

The preceding page shows a frontier mill, combining in one view a saw mill and grist mill, both of simple construction and convenient arrangement. Either may run separately or both at the same time. Such a mill can be cheaply constructed; one water wheel answering both purposes; capable of being detached from either mill at pleasure. The wheel of medium size, ranging from 20 to 40 inches diameter, with gearing, shafting and pulleys adapted to the size wheel, and for the purpose intended. We can recommend this method in instances even where quite a permanent and durable arrangement is desired, although it is perhaps oftener applied to frontier use. The structures protecting the two kinds of mills may be made even more temporary than the illustration exhibits, if it is desired to expend the least amount for its successful operation. The grist and saw mills may both be of portable character, which will still further enable the easy and rapid completion of such an enterprise.

Water Power and Electricity.

This method affords an easy, and flexible means of transmitting power, to inaccessible points, and long distances; and is being successfully applied in many instances. We recently supplied two wheels giving 600 H. P. which is taken a distance of $5\frac{1}{4}$ miles; also one wheel of 550 H. P., for power purposes by this system, the distribution being at many points. Also three pairs of Samson Wheels, 20 inches, of 1800 H. P. taking the power 18 miles, and another 14 miles. We could name many other instances. Between the water-wheel, and the point where the power is to be used, three elements are placed; *first*, the generating dynamo, which is attached to the water-wheel by belting or otherwise; this converts the mechanical energy of the wheel, into an electrical current; *second*, the wire which conducts this electrical energy, from the generating point to the point to be used; *third*, the motor which receives the current from the line wire, and re-converts it into motion, this motion being applied to the machinery by belting from the motor.

The cost of such transmission varies with the conditions. Great distances involve a large expense in the line wire, which is made of copper. A reduction of the cost in the line wire involves greater expense in the generator; on the contrary, a more expensive line reduces the cost of generator. Two methods are usually employed; one is known as the con-

tinuous current, and the other by the alternating or high potential line. An approximate estimate for a transmission of a mile distance based upon an 80 per cent. utilization of power, would involve an expenditure of about \$75 per horse power. This including the water wheel, would amount perhaps to \$110, or \$120, per horse power. Another page of this pamphlet gives an estimate of the comparative costs of different systems of power transmissions at distances. We will answer any inquiries on the application of wheels to electrical transmission.

Saw Mill Driven by Mining Wheel.

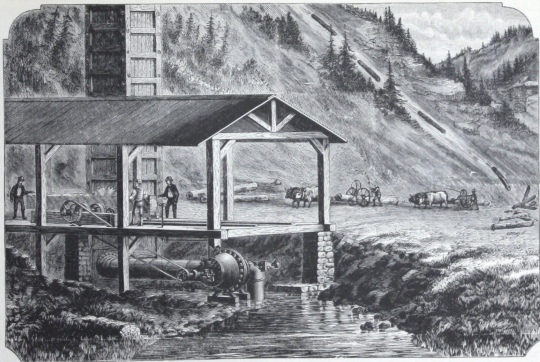
The opposite page exhibits a new and novel method of running a Saw Mill, with one of our Mining Wheels on horizontal shaft. The plan is exceedingly simple, cheap and convenient. The gearing which is almost always used where large wheels with Upright Shafts are adopted, is entirely obviated by this style of wheel. The Wheel should be some distance from the Saw, to obtain a sufficient length of belt, and may be either above or below the floor; below is usually most convenient, as it does not occupy floor space. When on the Mill floor a draft-tube should be used, extending downward till it dips into surface of tail water three or four inches.

A wooden penstock is herewith shown of more than usual height, extending above the view in the picture; it is connected to the dam or race by a horizontal part not shown. An iron pipe with an elbow attached to bottom of penstock, running horizontally, conducts the water to the wheel. The wooden penstock may be avoided, by using an iron head pipe running from the wheel any distance or at any angle, until it reaches the dam or bulk-head, where the supply of water is obtained. This plan for Saw Mills is best applied where the head is of considerable height, and the wheel of small dimensions. The high speed is quickly and simply reduced, by belting directly from the Wheel shaft pulley, to a pulley of suitable size on the Saw mandrel. The simplicity of this plan commends itself to all who desire an efficient and easily managed Mill; there is no question as to its excellence, if parties want the simplest method of application.

Transmitting Machinery.—(Shafting, gearing, pulleys, etc.) We are prepared to furnish promptly all styles of transmitting machinery. Careful attention is given by our firm to designing, proportioning, and arranging, as well as supplying the best gearing, shaftings, pulleys, etc., that are made at the present time. We supply from the lightest to the heaviest gears and shafts that water power plants or water wheels require. It will please us to furnish plans and estimates of cost of entire water power plants for all purposes.

Mechanical News House Plans, a book of designs for cheap, tasteful and comfortable houses, ranging in prices from \$500 to \$3,000. It contains 240 pages, nicely illustrated, and bound in cloth. Written and published by James Leffel & Co. Price \$2.00, postage paid.

Geo. B. Coughdon, Mgr. Woolen Mfg. Co., Beaver Dam, Wis., says: "The new Leffel Samson 45-inch, bought of you in December, was started in January, and is a little captain. We bought it for an auxiliary wheel, but it alone drives our mill strongly, and is what we call a very cheerful wheel."



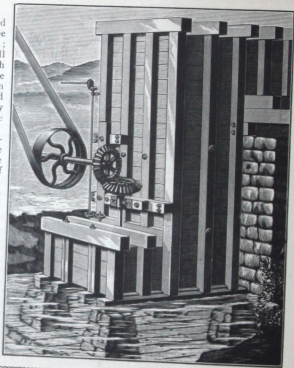
JAMES LEFFEL MINING WHEEL DRIVING CIRCULAR SAW MILL.

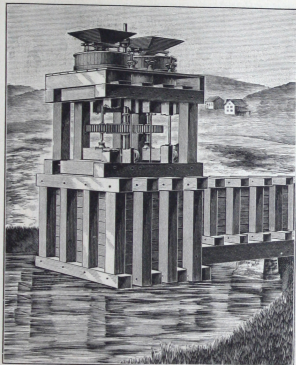
Decked and Open Top Penstocks.

A substantial flume is constructed with heavy timbers and a firm foundation. The stone piers and the back walls may be placed upon planking, providing the foundation is a soft one; or upon stone if the bottom of pit is of that material. In all cases the level of tail water when standing, ought to be as high as the top surface of sill containing the floor planking. The space below sills, page 66, was left that the placing of the sill on the wall and the pier might be seen; but the water should cover all of these, that the full benefit of the head and fall may be had, by the tube or cylinder extending down from the wheel, touching the water.

There must be sufficient space, in depth and in width, between the floor of flume and the floor of tail race, to let the water pass out freely and without obstruction, from the flume or penstock after leaving the wheel. The floor should be of heavy planking, to support the combined weight of wheel, water, shafting and gearing. The floor of these penstocks should have a hole of proper size to let the cylinder of wheel casing pass through and touch the tail water, and to let the wheel rest by means of the flange of its casing upon the floor. The wheel will not require any fixing to its place as its weight and the water will hold it in position.

The penstock is a mere continuation of the flume or forebay except that it has a greater depth and strength; the planking of forebay or flume being merely extended into the penstock. The floor should come near the standing tail water, that the end of the cylinder of the wheel casing will dip two or three inches below the surface of the tail water, as seen on pages 28 and 30. A pit of good depth should always be dug underneath the flume to prevent the water reacting against the wheel, whereby the amount of power would be diminished. This penstock can be constructed to





suit the location; the essential points being strength and sufficient capacity to let the water to the wheel without obstruction. The open penstock shows the Mill stone husk upon the penstock timbers; it may be built independent of it as on page *sixty-six*.

Don't Buy a Poor Wheel.

Do not purchase a common water-wheel, because from its *low price*, it may seem to be cheap.

It costs as much to erect an inferior wheel as it does one of the most superior quality.

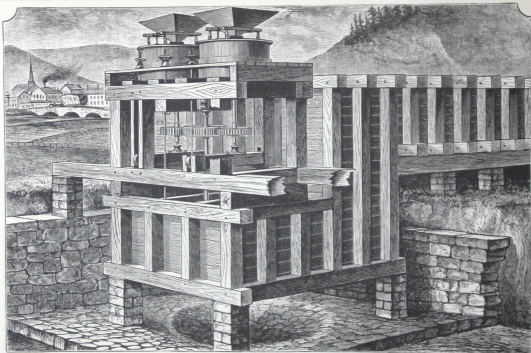
It is often necessary to discard an inferior wheel, and substitute one of better quality. This generally requires a change of gearing, and other alterations, involving a large expense which might have been avoided, by choosing the best water wheel at first.

The best wheel is that which does the most work, from a given quantity of water, and which is most easily managed, which has easy operating gates, and which is most durable under use, and easily repaired when necessary.

The application of the *best wheel* adds greatly to the value of the water right, and mill improvement.

The *best is the cheapest*, because it does more work, *lasts longer*, and costs no more to erect than a common wheel.

Over 3000 Testimonial Letters, on file in our office. During our **32 years** business experience, in building and selling the James Leffel Wheels, we have received a very large number of letters praising our wheels; not only their performance, the care of management, handling, etc., but also their workmanship, style of finish, strength and appearance, also their nice easy working gates.



DECKED PENSTOCK FOR LOW HEADS.

Decked Penstocks—Direct Attachment.

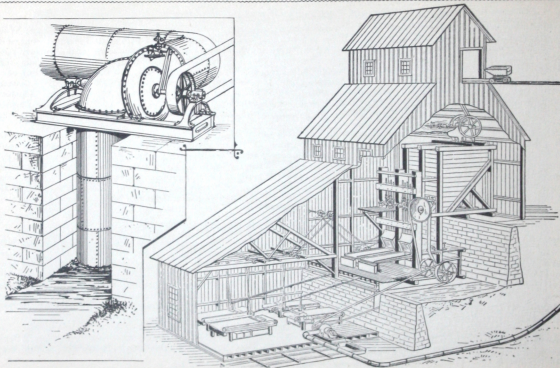
Some Flour and Saw Mills are so situated that it is difficult to gear the spindles, or horizontal shaft to the Water Wheel shaft above the surface of the tail water. This happens when the head water is on a level with second or third story of the Mill and the machinery operating on the first floor. The wheel can, in such cases, be placed as shown on the opposite page. Besides the upright portion of penstock, there is a horizontal section of flume built in which the wheel is placed. This decking may be three or four feet high on the inside when the head is about fourteen feet, and the water wheel of about twenty-three inches diameter. Other sizes of wheels and other heads require different heights of decking. The plate on opposite page shows a shaft attached to the wheel shaft, passing out the top decking of this horizontal section of penstock. Around the shaft is placed a stuffing box to prevent leakage of water; the gate rod having one also for the same purpose. The upright shaft may carry bevel gears for driving horizontal shafts for Saw Mills or other purposes, or spur gears, as seen in the cut, to drive Mill Burrs.

The advantage of this method of placing the wheel is that the power can be brought nearer to the point where the work is done, otherwise it would require a long train of gears and shafting, which would tend greatly to lessen the useful effect of the wheel. This style of flume must have strong heavy timbers and planking, which must be fitted closely, particularly at the joints, elbows or turns. The husk or frame supporting the Mill stones, is built upon a separate foundation, resting upon the stone walls, piers and abutments. There can be more timbers for supporting the Burrs and diagonal braces also used to stiffen and solidify the husk. The corner posts may be heavier than the illustration shows. By building the husk frame separate from the penstock, either of them can be renewed or rebuilt at any time.

Arrange Your Machinery to Suit The Water Wheel.

The value of a Mill depends largely upon the power to propel it. This is equally true whether the Mill is driven by Steam or Water Power; and in either case the machinery should be conformed and arranged with reference to the motive power. When applying a Water Wheel, do not attempt to conform to the wheel to the machinery, but on the other hand arrange the machinery with special reference to the wheel. The work should be done as near the wheel as possible, always avoiding great length of shafting and complication of gears or connecting parts wherever possible. The simplest connection to the wheel that fills the requirements should always be preferred. Excess of shafting, and too much gearing, always induces greater wear and friction, requiring greater attention to keep them in running order, incurring always a greater loss of power, than a plain simple plant.

Leffel's Book of Mill Dams, an illustrated book of 286 pages, devoted largely to construction of mill dams designed by James Leffel & Co. It contains much other useful matter to mechanics, engineers, and millwrights. Published by James Leffel & Co. Price 50 cents.



GOLD MILL AND JAMES LEFFEL MINING WHEEL.

Gold Mill And Mining Turbine.

The opposite page shows a Mill, for the reduction of ores, and is termed a Free Milling Gold Mill. It is without the complicated machinery, often required for the reduction of various gold and silver ores. Our Mining Wheel is similarly applied however, whether it be to a Gold or Silver Mill, a Concentrator, or Reduction Work; all being driven from a primary horizontal shaft. Our illustration shows the simplest kind of mill, requiring only an ore crusher in the upper part of building, and a suitable number of stamps and vanners in the lower part, which comprises all of the operating machinery. The ore crusher reduces the ore to an even size, and from this crusher it is run into bins or chutes, conveying the ore directly to the stamps, which pulverize it to a suitable degree of fineness. The stamps usually weigh from 150 to 850 pounds each, and are raised from 8 to 14 inches, making 60 to 100 drops a minute. They require from 1 to 3 H. P. per Stamp, and will crush from 1 to 4 tons per stamp per day, of 24 hours, depending upon the kind and quality of the ores.

A small constant supply of water is admitted to the mortar in which the ore is being fine crushed, and when reduced to a certain fineness, the supply water washes it through the screens of the mortar, by the dropping of the stamps, and it passes over inclined amalgamated and silvered copper plates, from which the gold is afterwards gathered. Our Mining Wheel driving this class of mills, avoids the necessity of gearing. This is desirable on account of the high speed of small wheels, applied to high falls, so often found in the mining regions. The wheel should be placed on a firm foundation, with the shaft level and parallel to the main horizontal shaft within the works. The power is then belted direct from a pulley on the Water Wheel shaft, to a pulley on the counter shaft and is thus easily and simply applied.

The water for driving a plant like the illustration, is usually conducted from some high point, by piping of any suitable size and length, for the power and quantity of water the stream supplies. The same power is obtained as if the water came directly over the wheel by a vertical pipe or penstock.

J. A. Shoudy & Sons, Ellensburg, Wash. "We are using two of your wheels, one 30 inch and one 35 inch special. The 30 inch is driving our flouring mill, of 100 barrels capacity, and the 35 inch runs the electric light; both giving entire satisfaction." (*Electric Light and Flour Mill.*)

C. C. Lowe, St. Elmo, Colorado. "The 13 $\frac{1}{4}$ inch water wheel I bought of you is a dandy. It drives two 30 and one 16 inch saws at the same time; can saw 10,000 shingles per day and 50 cords of wood, and it does not take a full gate at that." (*Shingle Mill, etc.*)

Case Bros., of Benzonia, Mich. "We are running at the present time one of your water wheels that has been in almost daily use for 25 years, and is doing excellent work to-day."

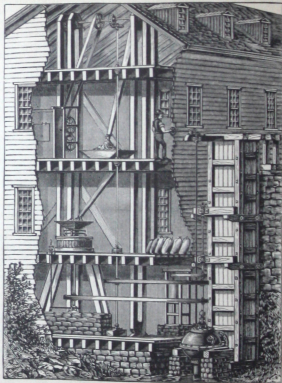
Rochester Electric Light Co., Rochester, N. Y. "We are using two of your 23 inch twin water wheels under an 80 ft. head, and it affords us great pleasure to give you a hearty endorsement of their work. They are better than we expected, and capable of furnishing much more power than you represented. For electric lighting they give us splendid service. Our light outshines them all." (*Electric Light Plant.*)

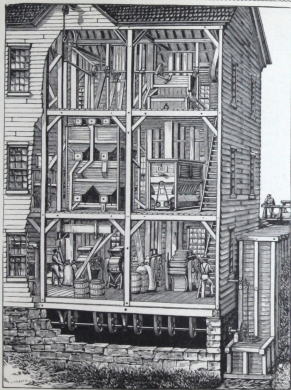
Flour Mills and Turbines.

Herewith are illustrated two styles of Flour Mills, showing a portion of the interior of each Mill. On opposite page is a modern Roller Mill driven by a James Leffel Wheel, placed in a decked wooden penstock; the power being transmitted through a pair of bevel gears, to a line shaft in the basement. The line shaft connects by belts, to the four Roller Mills seen in the picture. The upper part of building contains machinery, for elevating and cleaning the grain, and for separating and dressing the product. A Mill of almost any capacity, can be built upon this general plan; only an extension of the building and the shafting with additional machinery being necessary. A higher or lower penstock, using a larger or smaller wheel, can be built to suit the conditions.

The design of Mill on this page is extremely simple in detail; the Mill stones and the Upright Shaft of the Mill being driven by belting, directly from pulleys on the Water Wheel shaft. It shows also the greater simplicity and superiority of our Turbine over the Overshot. As a comparison, select an Overshot of 22 feet in diameter, and three feet face, to drive a small Mill under 24 feet head and fall. This size Overshot, constructed in the lightest possible manner, is very heavy and the weight is further increased by the water in the buckets; resulting in considerable loss of power from friction of the journals. The power of such an Overshot, would be transmitted to a large bevel wheel, about 12 feet diameter on the Water Wheel shaft, working into a small pinion on a large Upright Shaft passing through the Mill, and upon this shaft a large spur wheel is placed, working into a small pinion on the spindle, resulting in an enormous strain, and a large loss of power.

The principal objections to the Overshot, are the great expense in the construction, requiring heavy shafts, gears, etc., and the great loss of power from friction of the heavy machinery. Our Turbine in place of a 22 feet Overshot, would be perhaps 11½ inches diameter. The Shaft about 1¾ inches





diameter, instead of 10 inches, as with the Overshot. The Master Wheel, Bevel Pinion and Spur Pinion, weighing several thousand pounds, can be replaced by two or three small pulleys, weighing 40 to 50 pounds, on our Turbine Wheel. The Upright Shaft with the Overshot, is usually 5 or 6 inches diameter, while the extension of the Turbine need not exceed $1\frac{1}{2}$ inches. We obtain a quick motion from the Turbine and reduce it upon the machinery; while the slow speed of the Overshot requires an increase to a faster speed; thus *simplifying* with the Turbine, and *complicating* with the Overshot. The use of our Wheel not only saves in cost of machinery, but gains largely in its effective power, from simplicity of arrangement, and direct communication to its work.

Sanders & Co., Oronda, Washington. "To say we are pleased with the 35 inch special wheel bought of you, does not express our feelings; we are more than pleased. It gives all the power you claimed for it, and runs so even and nice, and is so easy to stop and start. If we should need a dozen wheels we should want them all to be the James Leffel." (*Saw Mill.*)

J. A. Miller, Lewiston, Idaho. "I have used the Leffel Wheels for 26 years, and have the first one to see that can compete with it in all respects."

Stone Fort Paper Co., Manchester, Tenn., state: "We have been using one of your special 35 inch wheels for driving our paper mill for the past seven years, during which time it has given us good satisfaction, and is as good as new yet."

McReynolds Bros., Cleveland, Tenn. "The 23 inch special wheel bought of you two years ago is giving entire satisfaction. Under 11 ft. head it runs a corn and wheat mill and a 52 inch saw. It replaced a 30 inch wheel of another make, and is a great saver of water." (*Saw Mill, etc.*)

Chase & Shinn., Chase, W. Va. "We have found the Leffel Water Wheel, No. 1 in all respects, and recommend it to users of water power."

Notice to Those Writing About Wheels.

Parties ordering wheels or asking for information should answer the following questions:

What is the head of water when at rest; or the vertical distance from surface of head-water to surface of tail-water?

If the stream is small, what depth and width of spill is there over a weir board as described in our article on measurement of water, pages 4 to 7; or, if an overshot has been used, state how wide and how much the gate was raised, and particularly how deep the water was above the gate opening.

If the stream is large, state whether a creek or river; and if possible give us a measurement according to our instructions for "large open streams," described and illustrated on pages 5 and 7.

What size and kind of wheel, if any, is at present or has been running, and how many square inches opening is there in the gates or wheel; and how many hours out of twenty-four will the stream supply it?

What kind of machinery do you wish to run, stating all the particulars you can?

If a corn or wheat mill, state whether old or new, size and number of burrs, how many bushels each one is grinding at present, how much you wish to grind on each, and how many will be running at once.

If a circular saw, state the size, number of teeth, and what speed it has; if a sash or vertical saw, state speed or number of strokes it makes, or is desired to make, and the length of stroke, in either case, state what kind of timber you intend cutting, and particularly what amount of feet, inch measure, you intend cutting in twelve hours.

If a woolen mill, give the number of sets of machinery, whether light or heavy, and kind of goods made; if a cotton mill, give the number of spindles, also of the looms, and the class of goods made, and whether old or new mill, and kind of wheel in use.

If a rolling mill, give size of rolls, number of revolutions per minute, and size of iron to be rolled.

What is the speed of your main line of shafting, and is it upright or horizontal?

Is the power to be taken off above or below the level of head water?

When there are main and connecting gears, always state whether they are spur or bevel, number of cogs, pitch of cogs, width of face of drivers and pinions, and the diameters of each wheel.

NOTE.—If it is impossible or difficult to obtain any of the foregoing data, with even a moderate degree of accuracy, we would like any other information, that may in some manner relate to the subject. A statement of some kind, will enable us to offer some advice, which we shall be pleased to give at any time.

Problems and Solutions.

To find the Circumference of a Circle, or of a Pulley: Multiply the diameter by 3.1416; or as 7 is to 22 so is the diameter to the circumference.

To find the diameter of a Circle or of a Pulley: Divide the circumference by 3.1416; or multiply the circumference by .3183; or as 22 is to 7 so is the circumference to the diameter.

To find the area of a Circle. Multiply the circumference by one-quarter of the diameter; or multiply the square of the diameter by .7854; or multiply half the circumference by half the diameter.

To find the diameter of a Toothed Wheel. Multiply the number of teeth by the number of *thirty-seconds* of an inch contained in the pitch, the product will be the diameter in inches and hundredths of an inch; or multiply the number of teeth by the true pitch and the product by .3184. These results give the diameter between the pitch lines and not the entire diameter from point to point of teeth on opposite sides.

To find the number of Teeth in Pinion to have any given Velocity: Multiply the velocity or number of revolutions of the driver by its number of teeth or its diameter, and divide the product by the desired number of revolutions of the pinion.

To find the Diameter of a Pinion, when the Diameter of the Driver, and the number of Teeth in Driver and Pinion are given. Multiply the diameter of driver by the number of teeth in the pinion, and divide the product by the number of teeth in the driver, and the quotient will be the diameter of pinion.

To find the Number of Revolutions of a Pinion or Driven, when the number of Revolutions of Driver, and the Diameter or the number of Teeth of Driver and Driven are given: Multiply the number of revolutions of driver by its number of teeth or its diameter, and divide the product by the number of teeth or the diameter of the driven.

To find the Number of Revolutions of the last Wheel at the end of a train of Spur Wheels, when the Revolutions of the first Wheel and the Number of Teeth or the Diameter of the First and Last are given: Multiply the revolutions of the first wheel by its number of teeth or its diameter, and divide the product by the number of teeth or the diameter of the last wheel; the result is its number of revolutions of the last wheel.

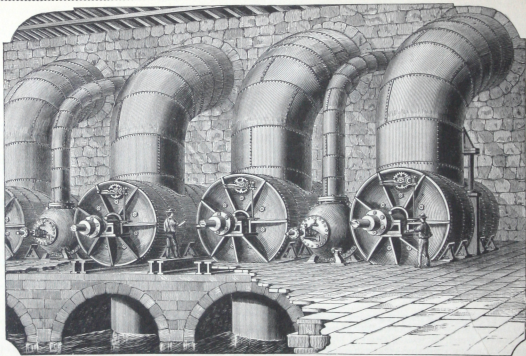
To find the Number of Teeth in each Wheel for a Train of Spur Wheels, each to have a given Velocity. Multiply the number of revolutions of the driving wheel by its number of teeth, and divide the product by the number of revolutions each wheel is to make, to ascertain the number of teeth required for each.

To find the Number of Revolutions of Driven Pulley, the Revolutions of Driver, and Diameter of Driver and Driven being given: Multiply the revolutions of driver by its diameter, and divide the product by the diameter of driven.

To find the Diameter of Driven Pulley for any desired Number of Revolutions, the Size and Velocity of Driver being known: Multiply the velocity of driver by its diameter, and divide the product by the number of revolutions it is desired the driven shall make.

To find the Diameter of Driving Pulley: Multiply the diameter of driven by the number of revolutions you desire it shall make, and divide the product by the number of revolutions of the driver.

3000 Complimentary Letters on File. The firm of James Leffel & Co., have been building the James Leffel Water Wheel for THIRTY-TWO YEARS; during this time many hundreds of letters have been received, from users of this Celebrated Wheel, containing terms of highest praise of its successful performance. These are on file in the office of the company; many of which have been published in various editions of the Leffel pamphlets. This edition is full of other useful matter, and space for a few extracts of letters only will be used for complimentary notices.



HUDSON RIVER PAPER AND PULP CO. WATER WHEEL HOUSE.

15 Leffel Wheels Giving 6,000 Horse Power.

MESSRS. JAMES LEFFEL & CO., 110 Liberty street, N. Y.: PALMER'S FALLS, SARATOGA CO., N. Y., May 11, 1885.

GENTS—In reply to yours of the 6th inst., asking "how our new wheels worked under the conditions we placed them," would say that we have no fault whatever to find with them; in fact, they are doing more work with less water than we calculated on, that is, the two sets or runs we put in and started last October (1884). They have been running almost constantly day and nightsince. We have only had occasion to look at them once since, and that was for the purpose of clearing out some blocks of wood that got in the canal below rack. As we knew of no similar work, or any of such magnitude as a precedent to go by we, naturally gave the planning of our motive power and connections a great deal of thought and study, and after looking over the various turbine wheels of different builders we decided on yours as having the greatest number of good points in its favor, and the satisfactory working of the two runs as mentioned confirms us in our conclusions.

After running the two sets (*1100 to 1200 horse power each*) day and night for six months we were so well satisfied with the results that we have erected two more sets, exact duplicates of the first two in every particular. We had a practical illustration that we studied very closely while in actual operation, and could not find a single point in any of the details that we thought we could change or alter to advantage. We expect to get the new wheels and machinery running next month, when we will have about 5,000 horse power in that mill alone. These wheels, cases, etc., are all contained and the power consumed in a room 70 by 80 feet, without the use of gearing or belts. Our wheels in the Pulp mill are placed twenty feet above the tail water; rather the bottom of the draft tube is twenty feet below the center of the wheels, and the water in the wheel pit stands one to two feet above the bottom of the tubes, making a column of water 18 to 19 feet in height hanging below the center of the wheel shaft. We have a vacuum gauge attached to the top of draft tube which indicates 16 to 18 inches of Mercury, showing that we lose nothing to speak of by placing the wheels on horizontal shaft and above the discharge water. Calling the specific gravity of the mercury 13.6, our gauge shows that the water in draft tube stands above the center of shaft.

In the fall of 1883 we placed two of your special size and built 44-inch wheels on our lower level, on a horizontal shaft under 28 feet head, and they have been working day and night ever since. They replaced a 60-inch wheel on an upright shaft. The old wheel was not able to drive half our present machinery up to speed on full work. These new wheels drive everything up briskly and not using full gate. We measured the water from old wheel and that used by your two 44-inch, and found the latter using considerable less water and giving us ample power. Formerly steps and gears bothered us, now we have neither step or gears. We have now *fifteen of your wheels* (all except one 23-inch) working on horizontal shafts, giving nearly 6,000 horse power.

Yours, truly,

WARREN CURTIS, Supt. Hudson River Pulp & Paper Co.

17 James Leffel Wheels on Horizontal shafts.

MESSRS. JAMES LEFFEL & CO., Springfield, O.:

PALMER P. O., SARATOGA CO., N. Y., June 22, 1891.

GENTS—We have 17 of your wheels in operation, and some of them have been in for a number of years and have given very satisfactory results; we have had very little trouble, if any, with the wickets, which is quite an item in a lumber stream

where so much bark and trash runs with the water. These wheels are from 44 inches down to 23 inches, and all on horizontal shafts and in iron wheel cases, under 50 and 32 feet head.

One of the pairs of 44-inch wheels under 50 feet head has been running night and day since 1885, with no changes whatever, and writer has his doubts whether any one has been into the wheel case since it started. Of course, this is the main thing with a wheel where there is plenty of water. As far as we can see, they give good power with economical use of water. Will you please make for us another special right-hand 44-inch wheel; we want this as an extra one; rough bore it $8\frac{1}{8}$ inches diameter, and ship it at your earliest convenience by freight.

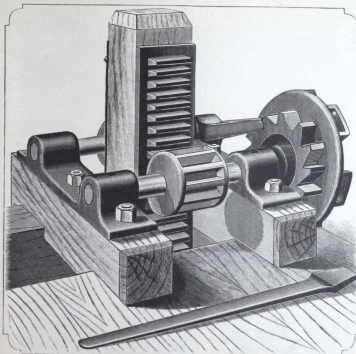
Yours, truly,

WARREN CURTIS, Treasurer Hudson River Pulp & Paper Co.

Water Wheel Gates Partly Closed.

The majority of James Leffel Wheels now in use, are operating at part capacity; the gates in many instances being partly opened and closed alternately, while the wheel is at labor, and often permanently set at a fractional opening. Wheels are often selected by customers and mill Architects, larger in size than necessary; but sometimes of large capacity, because of variable stages of water supply, and for various other reasons. It is not possible to design or construct a Turbine, that will give always equally good results in speed and economy of water, at any and all proportions of gate opening; but the imperfection may be to some extent removed in some kinds of wheels, but in no case so successfully, as has been accomplished in the Leffel Wheel. Our Wheels through their extensive introduction, during the 32 years of their manufacture by us, have made a wonderful record for successful performance, when running at part capacity. Many other wheels built by other parties, realize a poor economy of water, when their gates are partly closed; and unavoidably through their defective design, they become irregular in their work and speed; consequently difficult to regulate by a Governor, besides using too much water for the amount of work accomplished.

An instance is before us where a wheel built at present, has obtained a good reputation for high percentage, by persistent and continuous publication of test flume reports, in advertisements and various trade circulars. It is not generally known however, to the public, that these advertised reports by the makers of that wheel, are entirely and exclusively full gate results. An official report of tests of eleven of those wheels, shows that an average of only 41 per cent of useful effect was obtained when running at half gate opening, and using half the quantity of water, that it required at full capacity. The James Leffel Wheel under those conditions, particularly the late new Samson, either in practice at actual work, or under observed, competent, honest percentage tests, would have given a remarkably high useful effect; this it has conclusively shown in numerous practical instances. This high economy of water under part capacity or partially opened gates, that we realize, secures high regularity of motion, whether under the control of a Governor or otherwise; rendering it peculiarly well adapted to powers requiring intermittent work, or enables the customer to use a wheel of somewhat larger capacity than the stream. We have many letters on file, speaking in highest terms of praise, of the satisfaction our wheel is giving, running at all stages of gate opening from a quarter to full open gate.



HEAD GATE HOISTING APPARATUS.

Head Gate Hoisting Fixtures.

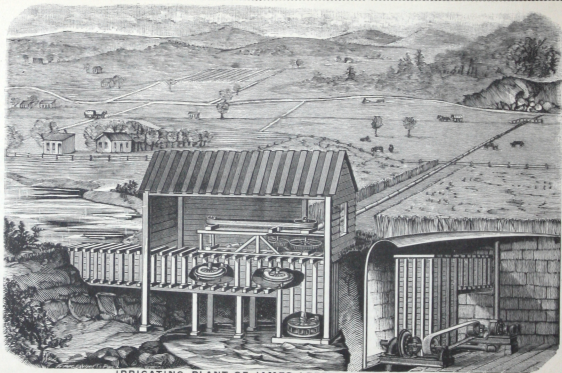
This illustrates a simple gate hoisting design, which is frequently used. It consists of an upright wooden stem, or post, fastened below by bolts, or otherwise, to the sliding gate that covers the square or rectangular opening, admitting water into the penstock. The stem carries a straight iron rack, into which the pinion works, for carrying the gate up and down,—this pinion being rotated by a detachable lever which is dropped into mortises on a ratchet head on the pinion shaft.

A roller is placed behind the gate stem on a shaft parallel to the pinion shaft. This prevents the gate stem from falling away from the pinion. The end of this roller shaft carries a pawl, which drops into the teeth on the ratchet head, thereby holding the gate at any height, or while the ratchet head is being operated. We can furnish the irons for several sizes of this gate, with plans for attaching them; and will quote prices on application.

Myron D. Stevens, Golden, N. Y. "I am running a saw mill that has one of your wheels which has been in constant use for nine years, and is in good repair. I can see no reason why it will not last a life-time."

Shafting, Gearing and Pulleys.

We furnish all styles of transmitting machinery. Our firm gives careful attention to designing plants and supplying the best shafting, gearing and pulleys that are made anywhere.



IRRIGATING PLANT OF JAMES LEFFEL WATER WHEELS.

Raising Water for Irrigation.

Water is frequently elevated by machinery for irrigation purposes, where there exists no natural source of supply, sufficiently elevated to afford the usual distribution by gravitation. The several methods for raising water comprise two main features, viz: the motive power, and the pumping machinery. The motive power consists of wind, steam, or water power. The first is light and irregular, the second very expensive, while the last is of frequent occurrence and often comparatively inexpensive. The elevating apparatus consists of a variety of Pumps, built upon both Rotary and Reciprocating principles; the latter being used almost exclusively with wind power, both styles, however, being applicable to steam or water power. The plan shown herewith is driven by our water wheel, using a form of Rotary Pump. This design affords the simplest possible wheel and pumping arrangement. The rotary motion of the wheel is carried directly to the pumps by a pair of spur gears, or a belt and pair of pulleys; the gears and pulleys being of such size and proportion, as to preserve the proper working speed of the wheel, under whatever head it may be placed; securing also the proper speed of the pump under its particular pressure.

The opposite page exhibits both the vertical and horizontal shaft water wheels and pumps; all arranged for the least amount of connecting machinery. Other styles of gear and pulley connections can be adopted, and reciprocating or plunger pumps connected by cranks and gears, if it is thought advisable. The pump, whatever style it may be, should take its supply of water from the head race, thus avoiding the use of more power and stronger machinery, which becomes necessary if the water is pumped from the tail race. When economy of power is desired, as large and as short piping as possible should be used from the bulkhead or race to the water wheel, and from the pipes to the reservoir or ditch. Large pipes pass the water at a slower velocity, therefore with less friction and less loss of power. There are limits to the sizes of these pipes in each instance, beyond which it would be a useless expense to go; and under certain limits the whole plant would prove a failure. It is often necessary to examine the problem with great care, that a proper adjustment of power, quantity of water elevated, expense of plant and other conditions, may so harmonize as to insure an economical and successful plant. We shall be pleased to advise concerning any of the details of Irrigation Works, and make complete plans of the power plant, when parties give us sufficient information by letter or otherwise.

Cotton Mill Water Wheels.

A very significant fact is the extent, to which the James Leffel Wheel has been adopted by Cotton Mill owners everywhere. These manufacturers investigate the quantities of a wheel more thoroughly, and with them a reliable power is a more vital consideration, than with proprietors of perhaps any other Mills. There is no class that more strongly objects to trying experiments in water wheels; and they demand that it shall have been proved to possess the greatest practical value. We could give a very large list of names of parties using our wheel, giving more than 40,000 H. P., in such Mills, in this country and in foreign countries. There is good reason for this exacting care, in selecting wheels for Cotton Mills; the nature of the business requires an enormous amount of power. It is also very essential that the power should be easily

controlled and regulated, as its available effect is easily influenced, by the steadiness and facility with which it is managed.

It is for these reasons that the Leffel Wheel has attained such extensive popularity, among the Cotton Mills of all parts of the country. It has proved its practical worth for a long period, under the most trying conditions and its superiority in amount and uniformity of power; and the ease with which it is controlled is unquestioned. The work of putting in the wheel should be done in a most substantial manner. Page 74 shows the method in which the Leffel Wheel is frequently set and arranged, although in this instance the wheel-house and setting, are shown of a large Paper and Pulp Mill; but is frequently adapted to power plants for Cotton Mills.

Capital Electric Light and Motor Company.

The opposite page shows a scaled drawing, for an electric and power plant, having three of our 20-inch James Leffel Double Discharge Wheels. Two of these have friction clutch pulleys on each side of the wheel, either pulley separately can be operated instantaneously, by means of a lever attachment. The elevation view shows clearly the style and application of a governor to each wheel. The proprietor, Mr. W. H. Ridenbaugh, of Boise City, Idaho, uses several other of our wheels for other purposes. We copy herewith from his letter of June 21st, 1891, as follows: The three Double Discharge 20-inch wheels, and one 5¼-inch wheel, and head pipes, etc., all fitted to plan nicely, and are now running satisfactorily under 62 feet head, and furnish ample power."

The Smith Paper Co. Use 27 Wheels.

JAMES LEFFEL & CO.

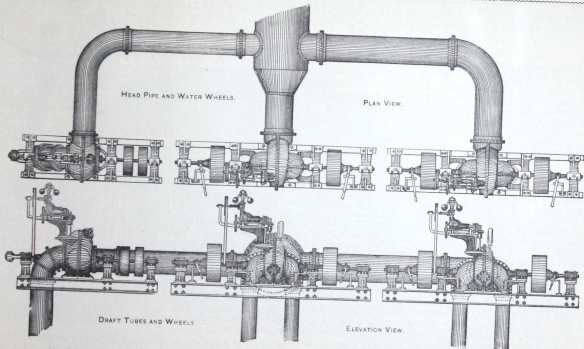
GENTS—It gives us pleasure to state your wheels continue to give us good satisfaction. We are running twenty-seven of your wheels from 20¼ 2 inch to 66 inch under heads, at our seven mills, varying in height from 9 to 15 feet. You are aware we just ordered another 125 H. P. Wheel of your make, which is the best testimonial we could give. Wishing you continued success, we are,

LEE, MASS., March 12, 1888.

SMITH PAPER CO., per WELLINGTON SMITH.

Nicely Balanced Water Wheel Gates.

Much importance ought to be attached to the design and style of gates, and the means of operating them. Our latest and best work, represented by the Samson Wheel, has the gates so improved and arranged, as to be almost perfectly balanced; enabling them to be operated quickly, easily and with a comparatively small amount of power. This is a great advantage in a number of respects. The wear on the cogging and moving parts being less, and the changes in opening effected quickly, all of which affords easy and rapid regulation by a Governor or by hand. Some styles of gate adopted by other kinds of wheels, are opened slowly under great pressure and difficulty, increasing wear and necessity of repairs, also preventing quick and easy regulation of the quantity of water, that an irregular or intermittent power requires. We quote from a letter by the Arkansas Milling Company, who displaced a well known Register Gate Wheel: "The 50 inch



ELECTRIC LIGHT AND POWER PLANT.

Samson James Leffel Wheel is doing our work in fine shape, and we consider it by far the best wheel in the market to-day. One great advantage of your wheel is, it will work a Governor, and this is more than many will do."

Central Discharge Twin Combination. (Style 12.)

The opposite page shows our Twin and Duplex Combination; consisting of two wheels, placed in a large Cylindrical Casing, similar to Style 19, page 49. The water discharges from the two wheels, uniting and passing downward through a central draft-tube. One pulley is shown in this instance, but the shaft can be extended at the opposite end, and the steel beams also lengthened, and a pulley placed on the shaft extension. A governor is attached in this instance for regulating the speed of the wheel. It is attached at one end and to one wheel only; at the other end of the casing, the gates of the wheel are operated by a hand wheel; frequently the same governor is attached to both wheels by extending the gate rod shaft across the outside of casing. The head pipe leading the water to the wheel, can be placed at any angle, from a horizontal to a perpendicular position. Correspondents and parties writing about, or ordering this style of horizontal shaft wheel, should not fail to let us know which direction it must run; whether the side of wheel next observer shall run up or down.

Which Way Must your Horizontal Wheel Run?

When writing about, or ordering a horizontal shaft wheel, be sure to inform us whether the side of the wheel, or the side of the pulley, next to the observer, must run up or down. The illustrations throughout this Pamphlet, present a number of forms of this, and often it is difficult to ascertain from the purchaser, how he wishes his wheel to run. Let us know on which side of the inlet or mouth piece the pulley should be placed; then inform us whether the face of the pulley, next the observer, should run up or down; and whether the mouth piece should be on the top or the side. An equally good method is to inform us whether the top or bottom of the pulley, should run to or from the observer, stating also at the same time, where the inlet is to be placed, whether on the top at an angle or on the side. It is positively necessary to understand this thoroughly before the work is done, and in making the order, we should be fully advised, or inconvenience, delay and perhaps disappointment will result.

C. C. Stevenson, Prop'r Douglas Quartz Mill, Gold Hill, Nev., says: "The two 35 inch wheels made for my Rock Point Quartz Mills, situated near Dayton, Nevada, proved a perfect success." (*Quartz Mill.*)

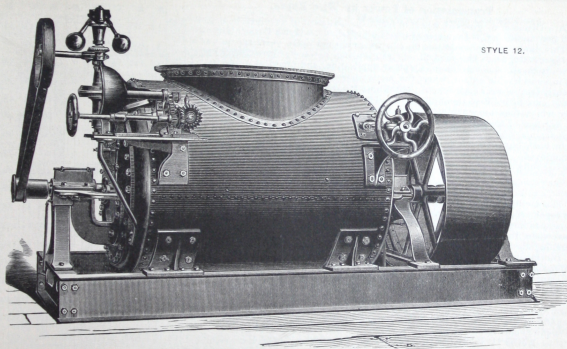
J. H. Johnson, Half Moon Island, Tenn., says: "I am driving my saw mill with 20 inch wheel purchased of you, under a 20 ft. head, and can cut 5000 feet of lumber (board measure) in 10 hours. I used a flutter wheel for 20 years under head of water, and could never saw more than 1000 feet a day." (*Saw Mill.*)

The House & Palmer Co., Lockland, Ohio. "We have been using your wheels for the past 15 years and think they have no equal. Are using a 35-inch making 100 barrels of flour in 24 hours under 14 ft. head, which we think hard to beat. We have also a 26-inch that has been running for 13 years, and have never spent \$20 in all that time on it for repairs."

BUILT BY JAMES LEFFEL & CO., SPRINGFIELD, OHIO.

83

STYLE 12.



DUPLEX COMBINATION CENTRAL DISCHARGE.

Transmission of Power by Wire Ropes.

A.—Diameter of grooved wheel in feet. B.—Number of revolutions of grooved wheel per minute. C.—Diameter of rope in inches. D.—Horse Power transmitted.

This table is a modification of one we published some years ago in our Mill-Gearing Catalogue. The method of transmitting power by wire ropes and iron sheaves is cheap in construction, simple in application, and practical in results. It is used to considerable extent, where the motive power and the factory can not be conveniently located near each other. Wire ropes for this purpose are always made with a hemp core to increase their pliability. Their durability depends on the conditions under which they are operated, but usually embraces a period of two to four years. The distance of transmission for which this table is intended, extends from 90 to 350 or 400 ft. in a single stretch. Where the stretch is slightly greater, a heavier rope can be used, but where it is extended much beyond this, intermediate pulleys must be employed. Power may be taken in this way a mile or more. We shall be glad to advise fully as to their application, cost, etc., in any particular instance.

Hemp Rope Transmission of Power.

This method admits of larger ropes, at much higher speeds than with the use of wire ropes. Frequently a number of them are placed side by side, on pulleys having a corresponding number of grooves; or in some instances one pulley having one more groove than the other, by which the rope can pass to a secondary pulley, used for tightening the whole system of ropes. Where a number are used, they are made in one continuous piece, and are not separate and independent ropes. The writer, a member of our firm, had experience with a sea-grass rope transmission as long ago as 1862, since that time the hemp rope has been used, and many improvements made. Recently we supplied a heavy power plant, including our wheels, pulleys, and ropes; in this instance using $1\frac{1}{4}$ inch rope in 9 strands. Dampness affects the ropes in this system more than in the use of wire ropes, and consequently they should be used in comparatively dry places. We will advise fully with pleasure at any time, as to all the requirements in any special case.

The 1700 H. P. Samson Wheel plant described on page 45, transmits from wheels to main line shaft by hemp ropes. Pulleys are placed on each side of the wheels, and each pulley has 16 grooves and 15 one inch ropes.

A	B	C	D	A	B	C	D
3	80	$\frac{3}{8}$	3	7	140	$\frac{1}{8}$	35
3	100	$\frac{3}{8}$	$3\frac{1}{2}$	8	80	$\frac{3}{8}$	26
3	120	$\frac{3}{8}$	4	8	100	$\frac{3}{8}$	32
3	140	$\frac{3}{8}$	$4\frac{1}{2}$	8	120	$\frac{3}{8}$	39
4	80	$\frac{3}{8}$	4	8	140	$\frac{3}{8}$	45
4	100	$\frac{3}{8}$	5	9	80	$\frac{3}{8}$	48
4	120	$\frac{3}{8}$	6	9	100	$\frac{3}{8}$	60
4	140	$\frac{3}{8}$	7	9	120	$\frac{3}{8}$	73
5	80	$\frac{7}{8}$	9	9	140	$\frac{3}{8}$	84
5	100	$\frac{7}{8}$	11	10	80	$\frac{1}{2}$	68
5	120	$\frac{7}{8}$	13	10	100	$\frac{1}{2}$	85
5	140	$\frac{7}{8}$	15	10	120	$\frac{1}{2}$	102
6	80	$\frac{1}{2}$	14	10	140	$\frac{1}{2}$	119
6	100	$\frac{1}{2}$	17	12	80	$\frac{3}{4}$	99
6	120	$\frac{1}{2}$	20	12	100	$\frac{3}{4}$	124
6	140	$\frac{1}{2}$	23	12	120	$\frac{3}{4}$	149
7	80	$\frac{3}{4}$	20	12	140	$\frac{3}{4}$	170
7	100	$\frac{3}{4}$	25	14	80	1	141
7	120	$\frac{3}{4}$	30	14	100	1	176

Water-Wheel Power Connections.

This illustration represents the Water-Wheel with upright shaft, and three general principles of transmitting power to various kinds of mills. These plans show Spur Gearing, Belt Connection and Bevel Gears, which cover the usual methods of transmission.

The Spur Plan, is adapted to driving millstones, and any upright shaft setting off from the Wheel Shaft. The gear teeth should be smooth and well proportioned.

The Belt Plan, is applied to Mill Spindles or Uprights too far from the Wheel Shaft to be connected by Spurs. This makes a smooth and noiseless transmission.

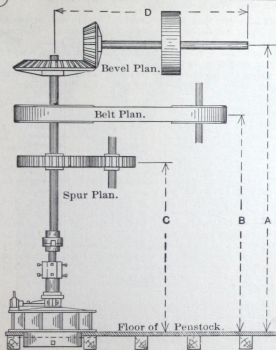
The Bevel Plan, is the most general application of the three, as the power is changed directly from an upright shaft to a horizontal. This last shaft affords an easy and quick connection, either by Spurs, Bevels, or Pulleys, to almost any and every kind of machinery to be driven.

Parties ordering the Upright Shafts of us to be connected to their Water-Wheels, ought to give us the measurement "A," and when wishing a horizontal line, the measurement "D" should be furnished. We furnish Gears, Shafting, Pulleys,—in fact every kind of transmitting machinery.

If Spurs or Pulleys are to be placed on the Water-Wheel-Shaft, it is desirable that we know the distances "C" and "B," in order to key-seat and locate the machinery.

The Stewart Paper Co., Brookville, Ind., state: "In our experience with water-wheels, the Leffel is the most practical of any we have used." (*Paper Mill*.)

We have **3000 Testimonials** on file in our office, praising the James Leffel Wheel in highest terms.



Spur, Bevel, Mortise, Angle Tooth and Worm Gearing.

The illustration herewith requires no description. It may be said however, that James Leffel & Co., are well prepared at all times, to make and to furnish the most approved gearing of all styles and descriptions, and of any capacity. Customers are thereby enabled to obtain the whole power plant, including water wheels and connections at one house. This subject has had our thoughtful attention, during the many years of our business, building the James Leffel Water Wheel; many of which have been supplied with complete plants of properly designed, well constructed, and fine proportioned gears. These being specially adapted to the size, and speed of the water wheels, the power obtained, and the purpose to which they are applied; all of which requires careful study, to obtain the proper relations, and proportions throughout.

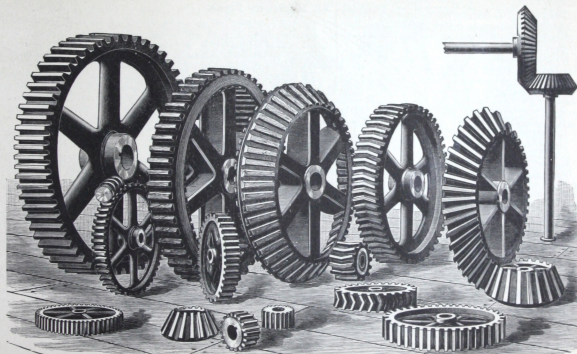
Trade Pirating Concerns.

We have published in several editions of our Pamphlet, a decision and decree of the United States Circuit Court, in a suit brought by James Leffel & Co., against a firm Thomas Leffel & Co., who built and sold a so-called Leffel Wheel. A Superintendent of our Works, together with two or three others once connected with us, organized the so-called Thomas Leffel & Co.; with the undoubted intention of establishing a business, as their name and methods indicated, upon the reputation of our Leffel Wheel, and our well established name, by pirating and catching a part of our trade. The parties having neither the originality, or inventive genius necessary to a well established wheel and business, depended upon an imitation of our wheel and our well known firm name, to supply their want of mechanical ingenuity and business sagacity.

The Court completely sustained the suit of James Leffel & Co., confirming the validity of the patents, decreeing and rendering an injunction, forbidding the manufacture and sale of the so-called Leffel Wheel, by the said Thomas Leffel & Co.; thereby justly sustaining our right in the name, in the wheel and in our well earned trade. The company afterwards went out of business; a natural sequence of ill-advised theft of trade and business name. We are again experiencing a similar injustice from another concern, who by trick and cunning, by a name quite like the above, and similar to our own, and by other questionable methods, are attempting a like raid upon our trade and reputation; hoping thereby to appropriate and enjoy our benefits. We have already obtained preliminary decisions of high authority, in our favor against them; and will endeavor to protect our custom and trade, against their deceptions and deceits now being practiced.

Shafting, Gearing and Pulleys. We furnish promptly all styles of transmitting machinery. Our firm gives careful attention to designing, proportioning, arranging and supplying the best shafting, gearing and pulleys that are made at the present time. We furnish all these in the lightest to the heaviest Patterns that Water Power Plants require.

Over 3000 Testimonial Letters, on file in our office. During our **32 years** business experience, in building and selling the James Leffel Wheels, we have received a very large number of letters praising our wheels; not only their performance the care of management, handling, etc., but also their workmanship, style of finish, strength and appearance.



SPUR, ANGLE TOOTH, BEVEL, MORTISE, WORM GEARING, ETC.

Complete Pit Machinery Plant.

The opposite page is designed from complete machinery plants, that we have recently supplied. The water-wheels are placed in a stone penstock, the shafts are observed extending upward, upon which large master Bevel Mortise Wheels are placed; these bevels work into pinions on the Horizontal, which carries one or more large transmitting pulleys. Heavy iron bridge trees are shown, securely fastened to the capping of the stone penstock. These again carry the secondary bridge trees, for supporting the upper bearing of wheel shafts, and the bearings of the horizontal shafts.

This arrangement shows only two wheels, but may be extended much further, and can be connected into other wheels standing in line. We have furnished a number of such plants the past season, in which a greater number of wheels are connected. A plant having five of our $5\frac{1}{2}$ ft. wheels in line, was recently supplied by us, the entire arrangement being upon this plan. We are well prepared to furnish, on short notice, any of the gearing, shafting, pulleys, couplings, journal boxes, and bridge trees, that may be required, for any capacity of plant.

Our SAMSON Water Wheel PATENTS.

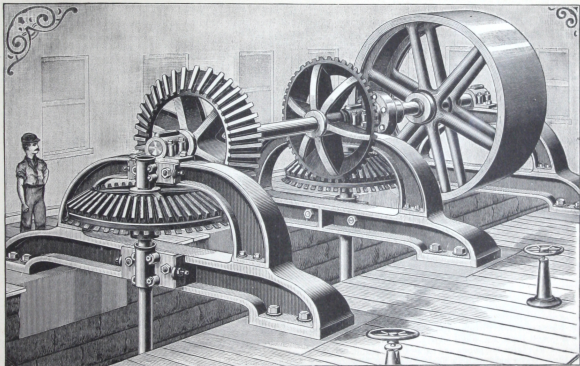
We beg to remind purchasers of Water Wheels, that either our Standard, Special or Samson James Leffel Wheels, are not liable to damages or annoyances, that frequently arise in the use of some late patented wheels, invented and patented by parties who are not fully advised, on the state of the art of water wheel building, and who have little or no experience in the business. Such patented improvements frequently infringe prior patents, because of the want of knowledge of the inventor, relating to the large number of designs already manufactured. Having been **32 years** in the business, and during the whole time building the James Leffel Wheel, we are fully informed as to all of the patents and improvements on the market. With this knowledge and the new industries and powers to which Turbines have been recently largely applied, we have added a number of important improvements to the wheel, (with which we have so much experience and are so well acquainted,) all of which we have patented under the name of our Samson Turbine.

The Samson Wheel does not infringe any one's rights, and it has so successfully and so generally shown and demonstrated its good qualities and excellence, in the past two or three years of its introduction, that parties interested in making and selling other wheels, will no doubt be prejudiced against it, and make false representations as to its merits, solely and wholly because of its real excellence, the competition it gives them, and because we have not given them, or any one else any rights as to its manufacture; the patents being intended for the protection of our own customers, and our large and well earned trade and reputation.

DIRECTIONS FOR SETTING THE LEFFEL WHEEL.

These rules are stated plainly, to avoid any misunderstanding in their application; if they are carefully followed, the wheel can not fail to work satisfactorily.

The Mill Dam.—The first step in improving a water privilege is the construction of a dam. Full and minute



COMPLETE PIT MACHINERY PLANT.

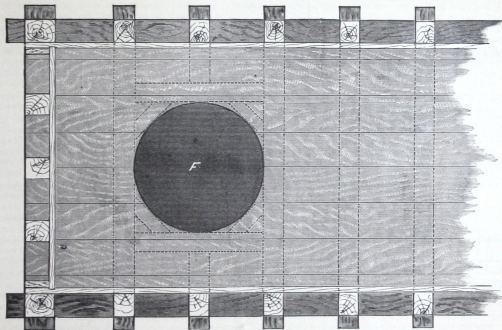
information on that subject, covering a great variety of forms, may be found in the "Mechanical News," published by James Leffel & Co. This contained some years ago a series of illustrated original articles on mill dams and their construction. "*Leffel's Construction of Mill Dams*," and "*Bookwalter's Millwright and Mechanic*," a nicely printed and bound book, finely illustrated with full page cuts, and published by James Leffel & Co., contains all that appeared in the "Mechanical News," and additional matter.

Head Race and Gates.—The next step is the construction of the canal or head race. A frequent error is committed by giving the head race insufficient capacity. It should be made wide and deep; this is especially necessary where the race is of considerable length, and is to furnish a large quantity of water. It is difficult to give a definite rule which will apply to all cases, but as a general rule the water should not flow faster than 80 to 130 feet per minute. The head frequently draws down from 1 to 3 feet, in long races, after the wheel has been running three or four hours. The effect of this is precisely the same, as if the dam had been lowered an equal distance, resulting in a loss of power which can only be prevented by making the race wide and deep. The book published by us on mill dams, contains practical information on this subject, and also on race and reservoir embankments.

The Tail Race.—This like the head race and wheel pit, should be wide and deep; and the level of bottom should be carried the whole length of the tail race to the stream, at considerable depth below the standing level of the water. This is easily done when the race is short. If a good depth can not be had the whole length of the race, it should be made wider, and the bottom of race for some distance downstream, or from wheel pit, should slope gently to the bottom of wheel pit, to avoid an abrupt rise. There ought to be standing water in the tail race, when the wheel is not running, to avoid rising of the water in the tail race, which occasions loss of head. Tail races should be much wider than usually made; and the sectional area should, if possible, exceed that of the outlet of the wheel pit. A wheel pit or tail race 3 feet deep and 10 feet wide has 30 square feet of sectional area. It is as important to have as wide and deep a tail race, as head race; neither can scarcely be made too large.

The Wheel Pit.—A sufficient depth of wheel pit, can not be too strongly impressed. It is a matter in which very frequent error is made. Whether under high or low heads, the pit should be made like the head and tail-races, deep and wide. There is no case where this is more important, than in the use of a large wheel running under a low head, as no loss of head, however small, can well be afforded. A small pit causes the water to react upon the wheel, and a further loss of power occurs in consuming a part of the head, to force the discharge water out the pit.

The table on pages 29 and 31 gives the usual measurements necessary in columns E, and E E, K and L; by which it will be observed the pit should be much deeper where discharging on one side only, than where discharging on two sides. If the water can flow through three sides, even a less measurement than that in column E E, might be used; these however are the lowest limit we would advise. If the pit has a sandy or muddy bottom, mud sills or cobble stones must be placed as shown in plates on pages 28, 64 and 66; and if the sills are used a plank floor of 2½ inches thickness should be placed upon them. It would make a fine job to cross the planking, making a double floor, each 2 inches thick.



FLOOR PLAN OF PENSTOCKS FOR JAMES LEFFEL WATER WHEELS (SEE FOLLOWING PAGE.)

A rocky bottom does not require mud sills or plank, but must be blasted out to give sufficient depth of standing tail-water; the depth should be continued the whole breadth of flume, and from two to four feet beyond the sides, where possible; but in all cases, the depth should be extended from 5 to 20 feet, down the tail-race from the end of flume. The tail-water should in all cases, touch the discharge tube, or cylinder of the wheel. Where very large wheels are used under low heads, the level should stand slightly above the floor of the penstock where the wheel rests.

Size of Penstock.—Columns B, pages 29 and 31, give the inside diameter of penstock for all sizes of wheels. These are the least dimensions, which it is expedient to employ, in using a special wheel. They are ample and abundantly large for the standard wheels, as these use less water, giving correspondingly less power. The first named page relates to Standard and Special wheels, and the last, page 31, to Samsons.

Size of Flume or Conduit.—The Head flume or forebay leading water, should be large enough to deliver the water quietly in the penstock without loss of head. The water in the penstock, to give the best results, should be nearly without motion, except the natural current towards the wheel. That there may be no mistake as to the size of the flume, for either Standards, Specials and Samsons, we give in columns B and BB, pages 29 and 31, the width and depth or cross section of water leading to the wheel. This depth is intended for the lowest stage; if the head is likely to draw down and become less, provision should be made for greater depth of flume. For example: a 35-inch Standard or Special wheel, according to the tables should have about 16 square feet, or a depth of flowing water at lowest stage of 36 inches, and a width of 64 inches. The flume should be about 6 inches higher than the highest level of head water.

Construction of Lower Timbers and Floor of Penstock.—Page 91 gives a general idea of framing the bottom of penstock for our wheels. This plan will not cover every variety of case that may arise; but it will give a good idea of the method of framing timbers under the floor, and around the cylinder of wheel. A number of other plans of framing a bottom to suit certain locations, will readily occur to a practical millwright. Light, weak timbers should at no time be used for the bottom of penstock. The side sills may be 12 inches square for a head of 10 to 15 feet; the intermediate posts 10 by 12, and the corner posts 12 by 14. Lighter timbers may be used for lower heads, and heavier ones should be used for higher heads. The intermediate sills may be narrow one way, and placed edgewise up and down; large flumes may have the sills supported by 2 or 3 posts about 4 inches square, placed solidly on the floor foundation of pit. Column F of table, pages 29 and 31, gives distances timbers should be framed apart, to admit the wheel cylinder.

Pages 28, 30, 64, 65 and 66, show penstocks resting on stone piers. These piers are not always necessary, as the side posts of the penstock may extend down to the apron or bottom of pit; the lower ends of the posts resting on mud-sills, where the bottom is soft, or on rock if bottom is of that nature. Large penstocks should rest either on stone pillars or side walls; pillars being the best, where the wheel pit can be made wider than the penstock, to allow free discharge in all directions. The floor of flume should be made of 3-inch plank, tongued and grooved and spiked down. The hole F must be cut in this floor, to allow the cylinder of wheel to pass through. The diameter of this hole is given in column F, page 29 for Standards and Specials, and on page 31 for Samsons. Surrounding the hole, soft pine plank should be placed,

extending beyond the flanges of wheel, and beveled as shown on page 28. These planks should be leveled and planed off perfectly true; the flange of the wheel resting upon the planks, and the cylinder passing down through the hole, its end dipping 3 or 4 inches below the surface of standing tail water. The weight of the wheel, its casing, and pressure of the water, will hold it firmly in place without fastening.

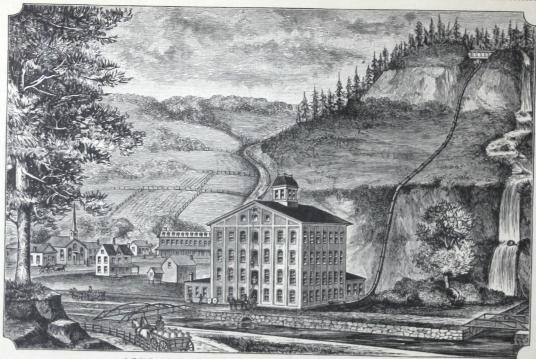
Open Penstock for Low Heads.—Low heads require plain penstocks; like pages 30 and 65. The pit, bottom timbers and floor are to be made as above directed. When the penstock is not too high, the floor of the forebay, or flume, should be on a level, or nearly so with that of the penstock, as shown on page 65; freer passage of water into the flume being thus afforded. The construction should be substantial, and according to the dimensions given in column B, page 29, shown in illustration on page 28 for Standards and Specials. The corner posts in medium size flumes should be 10 by 12, and higher flumes 12 by 14. The other posts 8 by 10 and 10 by 12. These intermediate posts should be placed from 2 to 3 feet apart, according to the thickness of plank, the heavier the plank the greater the distance between the posts. No particular kind of flume is required; the only essential point being to make it large and sufficiently strong, with a wheel pit and conducting flume of such size, as to give free entrance and discharge to the water.

Decked Penstocks.—It is often necessary to take the power from the water-wheel shaft, below the level of water in head race. The wheel in such instances can be placed as shown on pages 60, 64 and 66. The floor of penstock, the wheel pit, etc., should be constructed as described in foregoing articles on "Wheel Pit," "Size of Penstock," etc. The ordinary penstock has a horizontal portion attached; the top of this additional part being covered or decked below the point where the power is to be taken. The water-wheel shaft and gate rod pass through stuffing boxes, in this deck or cover, this to prevent leakage of water. When for any reason metal stuffing boxes can not be conveniently procured, the millwright can construct them of wood, to answer the purpose.

The timbers in the decked extension, should be as strong and substantial, as those in the main body of penstock; and a few bolts at suitable points, as shown on page 64, will repay their cost. The wheel shaft should be placed as near the main penstock as the nature of the gearing will allow. Pages 60 and 64, illustrate this point. This economizes space, and in many cases, a greater length of decked flume than is necessary will be avoided. Note the intermediate sills supporting the floor of penstock, are hung to the main cap by means of bolts, in plate page 64. We recommend this plan, as a front sill is thus kept from obstructing the free discharge of water; while the stone piers also admit of a free escape of the water in all directions, they afford also a good foundation for the whole structure. The decking of penstock may run under the mill any desired distance, placing wheel as nearly as possible to the machinery; thus saving power.

The Forebay Rack.—It is highly important that the rack across the race or forebay should be properly constructed. The bars should be enough apart not to obstruct the flow of water, and should be kept clear of all trash. Considerable head is often lost by this neglect, and the efficiency of the wheel thereby impaired. Full instructions on this subject will be found on page 24.

Draft Tubes.—Wheels under high falls are sometimes placed, at a distance above the tail water; and the water



LONG AND CROOKED HEAD PIPE. (SEE FOLLOWING PAGE.)

conducted from the wheel through an air tight tube called a draft tube. This tube also avoids the use of a long shaft, to some extent. It is desirable in some cases when the outlet is cramped, to employ a short draft tube, 2 or 3 feet long, to raise the lower timbers of penstock from the water, and allow a free discharge.

There is ordinarily no objection to the use of a draft tube, not to exceed 10 feet in length; as within that limit, by good workmanship and proper material, an air-tight tube can be constructed. A want of experience in the matter of proper construction, and application, may lead to mistakes which would greatly diminish the power of the wheel; we would therefore advise, as a general rule, that the wheel be placed at the bottom of the fall. When a draft tube exceeds 10 feet in length, particularly for small wheels, it should be made of boiler iron, in the most thorough manner, and perfectly steam-tight. Experience has taught us, that long wooden tubes can not be relied on, as either water-tight or durable. Great care should always be taken in getting the wheel placed air-tight on the top end of tube. The end of the draft tube should dip 4 or 5 inches below the surface of standing tail water; and the same care is necessary in making discharge pit large, as when the wheel is used without the tube.

Long Head Pipes.—The foregoing page shows a long, crooked head pipe; used with one of our small wheels, under a 96 feet head at Williams' Mill, N. Y. Page 56 shows the internal arrangement of Mill, and the wheel Globe to which the pipe is attached. The same useful effect can be obtained, and the same power realized, by placing pipes at an inclination, that can be had by having the water directly over the wheel. The power in either case is due to the perpendicular distance between the head and tail levels of water. The pipes should be large and ample, to carry the water to the wheel at a low velocity, to avoid loss of head pressure by friction. Abrupt and square turns should be avoided; and long easy curves always used. The lower part of piping should be well anchored, to prevent the weight of pipe and water pushing the wheel out of true on its foundation.

A. C. Cutter, Farnsworth, Mich., writes our company as follows: "I have the Samson 20-inch Wheel working and it is a dandy. It is all you claim for it."

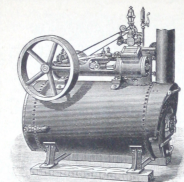
B. C. Oneal, Wild Goose, Tenn., says: "The Samson 26-inch Wheel purchased of you is as good a wheel as I want. I can saw three to four thousand feet of lumber per day; I can run two 50 saw gins and a 36-inch corn mill at same time, with one-half gate, under 9 feet working head. I can't see how much better one could wish."

M. H. Thomas & Son, Red Level, Ala. "The 20-inch Samson Water Wheel purchased of you gives perfect satisfaction. It is really delightful. We are running a 40 saw gin and 36-inch corn buhrs, with one-half gate, and gin from five to six bales cotton per day, and grind in proportion. Head 13 feet. We can testify that it has no equal."

Good for Another 30 Years. **A. W. Gray's Sons**, Middletown, Vt., write as follows: "We have one of your Double Turbine Wheels now running in our Factory, where it is running every working day with the exception of an occasional lay off for shop repairs, for something over 30 years and it is still at it, doing well, and good for another thirty, so far as we can see. Have you got any one that can beat this record?"

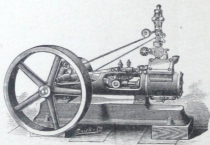
ENGINES and BOILERS.

Brief mention is here made of our Engines and Boilers, in the manufacture of which we were early engaged. The high reputation achieved by the splendid success of our Water Wheel in furnishing power resulting in our receiving many applications for steam power also. That our efforts to meet this demand in the fullest measure have been successful, is abundantly attested by more than 4,500 we have introduced giving excellent results.



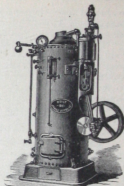
Horizontal, Centre-Crank, Engines and Self-Contained, Return Flue Steel Boilers, we now build in a large number of sizes, above,

5, 8, 10, 16, 20 and 26 Horse Power.



Improved Upright Engines, with Submerged Tubular Steel Boilers. We furnish in various sizes, above,

3, 4½ and 6½ Horse Power.



We publish a separate Pamphlet devoted exclusively to illustrating and describing our Engines and Boilers. Copy of which, with prices, will be sent on application, stating power wanted, or kind and size machinery to be driven.

JAMES LEFFEL & CO., Springfield, Ohio, U. S. A.

LEFFEL COMPLIMENTS.

Smith Paper Co., Lee, Mass., state: "We are running 27 of your wheels from 20 inch to 66 inch under heads, at our seven mills, ranging in height from 9 to 15 feet. We just ordered another 125 H. P. wheel of your make, which is the best testimonial we could give." (*Paper Mill.*)

Wm. E. Pierce, Allenton, R. I., says: "I have had the ordering of a dozen or more turbines of your make, and now have in operation for myself a 20 and a 44 inch that have been in use 20 years. I have yet to find a wheel that will beat them."

Ives & Miller, New Haven, Conn., say: "We have used one of your 23 inch and a 48 inch wheel for 18 years, and consider them altogether the best made."

S. A. Ladd, Treas. Meredith Mechanic Association, Meredith, N. H., says: "We have in use 3 of your 20 inch wheels. The first one was purchased October, '67, the second one, July, '79, and the third one, April, '80. These wheels have been in constant use since they were purchased, and are about as good as new, even the oldest one. Head 40 feet. (*Meredith Mechanic Association.*)

Lane & Gale, Troy, N. Y., state: "After an experience of 15 years in the use of your turbine wheels, we are well pleased with their efficiency. Four years ago we wanted a new wheel for our Johmanith factory, and put in yours, which is the best evidence we could give of our opinion of your wheel."

H. Smith Co., Grafton, Wis., state: "The 44 inch special water wheel we bought of you works excellent. Under 13 and 14 ft. head at $\frac{3}{4}$ gate it drives the whole mill, containing 18 pair rolls, etc." (*Flour Mill.*)

W. P. Farmer & Son, Murphy, N. C., say: "The 35 inch turbine of your make is a success in every particular. So far it has proven as steady as the water that runs it, leaving no room for any other than words of praise."

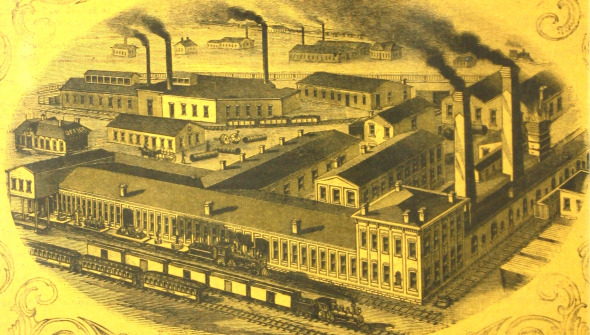
Bearden & Thomas, Fayetteville, Tenn., state: "We have one 56 inch Leffel wheel that has been in constant service since 1868, and one 66 inch since last September, and could not wish for any improvement on either."

W. Allen & Sons, Pushmataha, Ala., state: "We have been using your wheels for 18 years, trying others before that time, but have found none that will compare with the Leffel for power, durability, economy of water, etc." (*Flour Mill.*)

Carbot Mfg. Co., B. Green, Agt., states: "We have been using 5 of your turbine wheels for 15 or 20 years; they have done good service and we are entirely satisfied with the work." (*Cotton Mill.*)

Taggart Bros., Watertown, N. Y., state: "We have at present 8 Leffel wheels in operation, some of which have been in use over 20 years and are giving good satisfaction." (*Paper Mill.*)

(James Leffel Water Wheels. Built by The James Leffel & Co., Springfield, Ohio.)



WORKS OF JAMES LEPPÉL & CO.